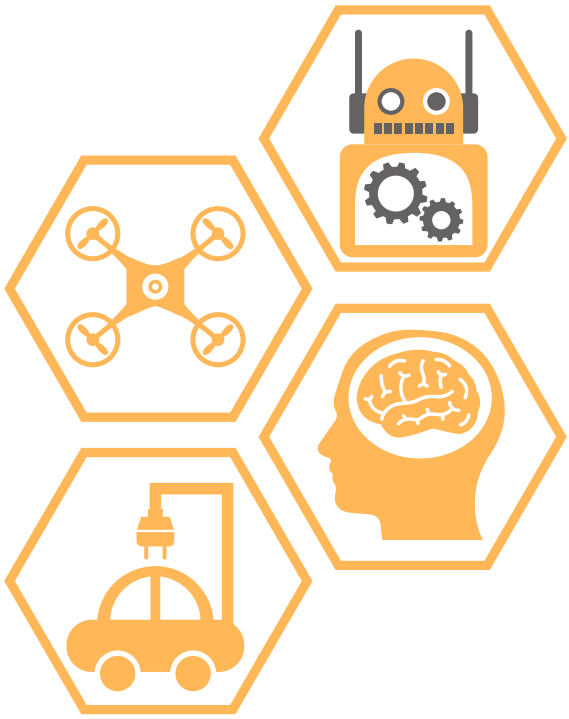
FUZZY 2018

中華民國第二十六屆模糊理論及其應用研討會

The 26th National Conference on Fuzzy Theory and Its Applications

會議手冊

主辦單位：銘傳大學電腦與通訊工程學系
協辦單位：中華民國模糊學會
中央大學
科技部工程科技推展中心



Nov 05-06, 2018
Taoyuan City
Taiwan

目錄

序言

模糊理論及其應用研討會是國內關於模糊理論各項議題中最盛大之學術會議，今年為第二十六屆，很高興能由銘傳大學主辦，竭誠地歡迎各位模糊理論界的精英齊聚桃園南方莊園渡假飯店，分享及討論模糊理論的各項最新發展及應用，增加產官學界相互切磋及交流之機會。此次會議共收到超過 60 篇之投稿論文，在每篇論文經過 2~3 位評審委員之審查後，最終接受發表之論文數為 56 篇，在此感謝各位先進之大力支持。此外，大會很榮幸邀請到三位國內外知名之專家學者擔任大會的專題演講講員，分別為南韓國立首爾大學 Prof. Dong-Il (Dan) Cho，台灣國立清華大學 Prof. Bor-Sen Chen，以及日本京都大學 Prof. Fumitoshi Matsuno，相信本次會議將會帶給與會者不少收穫。

最後要感謝各界的熱心參與和協助，使得本次會議能順利舉行。首先感謝銘傳大學、國立中央大學、中華民國科技部、科技部工程科技推展中心、Taiwan Fuzzy Systems Association (TFSA)等單位協助宣傳、邀稿及給予經費上的贊助。同時也感謝大會指導委員、議程委員、籌備委員及評審委員對論文審查及議程規劃上的協助，最後特別感謝銘傳大學資訊學院與電腦與通訊工程學系全體師生及工作人員之辛勞，因各位的付出才有此次會議豐碩之成果。

第二十六屆模糊理論及其應用研討會

大會主席
王金龍
江叔盈
張嘉文
鄭錦聰

謹識

中華民國 107 年 11 月 5-6 日

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主題演講-I

Ion Control in MEMS Traps for Quantum Information

Speaker: Prof. Dong-Il “Dan” Cho

Monday, Nov. 5, 9:20-10:30
Place: 艾菲爾廳

Prof. Dong-Il “Dan” Cho received the B.S.M.E. degree from Carnegie-Mellon University, Pittsburg, PA, and the M.S and Ph.D. degrees from the Massachusetts Institute of Technology, Cambridge. From 1987 to 1993, he was an Assistant Professor at Princeton University, Princeton, NJ. Since 1993, he has been a Professor in the Department of Electrical and Computer Engineering at Seoul National University, Seoul, Korea. He is the author/coauthor of more than 120 international journal articles. He is the holder/coholder of 29 US patents and 82 Korean patents. He has served on the editorial board of many international journals. Currently, he is Senior Editor of the IEEE Journal of MEMS and IFAC Mechatronics. He was the President of ICROS and BOG Member of IEEE CSS, and is currently Vice President of IFAC, Chair of the Technical Board of IFAC, and AdCom Member of IEEE EDS. He is an elected Senior Member of National Academy of Engineering of Korea.

Abstract

Quantum information processing is a novel information processing method which encodes information into a quantum system instead of conventional digital electronics. By utilizing unique characteristics in the quantum regime, including superposition, entanglement, and teleportation, the quantum technology can be a disruptive technology in information processing. To build physical quantum platforms, a number of approaches are being developed. Among these, ion traps are considered as a promising architecture, because of the long coherence time, ideal isolation from the surroundings, and the capability of individual qubit manipulations. In this talk, world-wide research and development efforts on the topic are briefly introduced. And then MEMS-fabricated ion trap technology and physical control of ions, including basic principles of ion traps, MEMS-based approaches for constructing ion trap systems, and design optimization for junction ion traps and controlling ions are presented.

主題演講-II

Multiobjective H_2/H_∞ Control Design of the Nonlinear Mean-Field Stochastic Jump-Diffusion Systems via Fuzzy Approach

Speaker: Prof. Chen, Bor-Sen

Monday, Nov. 5, 10:45-12:00
Place: Eiffel Hall

Prof. Chen Bor-Sen received BS in electrical engineering from Tatung Institute of Technology in 1970, MS in geophysics from National 300 journal papers, including 120 pa Central University in 1973 and the Ph.D. degree in electrical engineering from the University of Southern California, Los Angeles in 1982. He is currently the Honorary Tsing Hua Chair Professor of Electrical Engineering at National Tsing Hua University, Hsinchu, Taiwan. He had been a lecturer, associate professor at Tatung Institute of Technology from 1973-1987. He had been the professor, chair professor and distinguished chair professor from 1987-2017. His current research interests are in control engineering, signal processing and systems biology. Prof. Chen have published about pers in control, 80 papers in signal processing and communication and 100 papers in systems and synthetic biology. Recently, he have also published 8 monographs in control, systems and synthetic biology. Prof. Chen has received the Distinguished Research Award from the National Science Council of Taiwan four times. He was awarded as National Chair Professor by the Ministry of Education Taiwan in 2011. He has also received the Automatic Control Medal from the Automatic Control Society of Taiwan in 2001. He is a Life Fellow of IEEE.

Abstract

The mean-field theory was proposed to describe collective behaviors resulting from individuals' mutual interactions in various physical and sociological dynamic systems. For example, in the stock market, if one wants to invest one stock, he not only considers the price of the stock but also consider the index of the stock market (i.e. the mean of all stock market). Recently, the mean-field stochastic system has become an active research field in control field. However, at present, it is still very difficult to solve the control design of nonlinear mean field stochastic system. In this talk, the multiobjective H_2/ H_∞ fuzzy control design is investigated for nonlinear mean-field jump diffusion (MFSJD) systems for concurrently minimizing both the H_2 and H_∞ performance. Since H_2 and H_∞ performance are usually in conflict with each other, the optimization problem which concurrently minimizes H_2 and H_∞ performance can be regarded as a dynamically constrained multiobjective optimization problem (MOP). Because the Hamilton-Jacobi inequalities (HJIs) of the nonlinear MFSJD systems are difficult to derive, the multiobjective H_2/ H_∞ control design problems of nonlinear MFSJD system are difficult to solve. The Takagi-Sugeno (T-S) fuzzy interpolation scheme and an indirect method are introduced to help us transform the dynamically constrained MOP into a linear matrix inequalities (LMIs) constrained MOP. Thus, one can accomplish the multiobjective H_2/ H_∞ fuzzy control design

via the LMI-constrained multiobjective evolutionary algorithms (MOEA). To efficiently solve the multiobjective H_2/H_∞ control design problem, we proposed a novel LMI-constrained MOEA called fronts-squeezing. The fronts-squeezing LMI-constrained MOEA can concurrently search the Pareto front from both sides of feasible and infeasible region and narrow the search region down to increase its efficiency. Finally, we present a simulation example about the multiobjective regulation of nonlinear MFSJD financial system to illustrate the design procedure and verify the proposed theories.

主題演講-III

Bioinspired Robotics and Its Application to Rescue and Recovery

Speaker: Prof. Fumitoshi Matsuno

Tuesday, Nov. 6, 14:15-15:30
Place: Eiffel Hall

Prof. Fumitoshi Matsuno received the Dr. Eng. degree from Osaka University in 1986. In 1986 he joined the Department of Control Engineering, Osaka University. He became a Lecturer in 1991 and an Associate Professor in 1992, in the Department of Systems Engineering, Kobe University. In 1996 he joined the Department of Computational Intelligence and Systems Science, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology as an Associate Professor. In 2003 he became a Professor in the Department of Mechanical Engineering and Intelligent Systems, University of Electro-Communications, Tokyo. Since 2009, he has been a Professor in the Department of Mechanical Engineering and Science, Kyoto University. He holds also posts of the President of the Institute of Systems, Control and Information Engineers (ISCIE) and the Vice-President of NPO International Rescue System Institute (IRS). His current research interestslie in robotics, swarm intelligence, control of distributed parameter system and nonlinear system, and rescue support system in disaster. Dr. Matsuno received many awards including the Outstanding Paper Award in 2001, 2006 and 2017, Takeda Memorial Prize and Tomoda Memorial Prize in 2001 and 2017 from the Society of Instrument and Control Engineers (SICE), the Prize for Academic Achievement from Japan Society of Mechanical Engineers (JSME) in 2009, the Best Paper Award in 2013 from Information Processing Society of Japan, and the Best Paper Award in 2018 from the Robotics Society of Japan (RSJ). He is a Fellow member of the SICE, the JSME, the RSJ and a member of the IEEE among other organizations. He served as a co-chair of IEEE RAS Technical Committee on Safety, Security, and Rescue Robotics (SSRR), an Editor-in-Chief of Journal of RSJ, an Editor of Journal of Intelligent and Robotic Systems, a chair of Steering Committee of SICE Annual Conference, a General Chair of IEEE SSRR2011 and IEEE/SICE SII2011, SWARM2015 etc. He is an Editor of Journal of Robotics, International Journal of Control, Automation, and Systems, an Associate Editor of Advanced Robotics etc. and on the Conf. Editorial Board of IEEE CSS.

Abstract

Our laboratory has been engaged in two broad and connected areas of research that relate to human surroundings: bio-inspired robotics and rescue robotic. Living creatures have survived and been optimized by natural selection. An understanding of the functions of living things is very useful in creating new artificial robots. In our lab, we are interested in

analyzing the beautiful skills and behaviors of living things, and we are trying to find solutions to the following questions, among others: Why can living snakes move without legs? Why do quadrupeds change their gait patterns (for example, walk, trot, gallop) depending on their speed of movement? What is the mechanism of the flocking behaviors of birds and fish? How can small ants build a big anthill? Why can human beings walk with two legs? Based on our understanding of these phenomena, we can apply our knowledge to create robots to solve industrial problems.

We believe that rescue robot systems are another important application of robotic technology. During my time as an employee at Kobe University, one of my masters student, Mr. Motohiro Kisoi, was killed in the Great Hanshin-Awaji Earthquake on January 17, 1995. Since this tragic event, I have been putting my heart into the development of useful rescue robot systems and rescue engineering. When the Great East Japan Earthquake occurred in 2011, we dispatched and utilized the rescue robots KOHGA3 to inspect damaged buildings in Hachinohe and Aomori, and we dispatched underwater robots to search for bodies in Minamisanriku, Miyagi, and Rikuzentakata in Iwate. My dream is to establish an international rescue robot team, like the popular TV show Thunderbirds, using advanced robotic technologies. If we can dispatch rescue robots from Japan to disaster sites everywhere in the world for disaster response and recovery, it will be a strong contribution to the world.

會場資訊

南方莊園渡假飯店

桃園市中壢區樹籽路 8 號

交通資訊

1.【台灣高鐵桃園站==會場】

A.【計程車】由高鐵桃園站至會場, 單程計程車費用約 NT$235 (此為預估車資).

B.【南方莊園接駁服務】接駁車僅提供**住宿客人**於住宿期間，定時定點免費接駁服務。接駁地點為高鐵桃園站(同機場捷運 A18 高鐵桃園站)，及中壢火車站。若須定時以外時間接駁，單趟收費$400 元，搭乘人數 8 位。接駁車採**事先預約制**，請於搭車前一日 17:00 前向飯店登記預約。.

Timetable: From 高鐵桃園站 to 南方莊園 *14:30, 16:00, 17:20, 18:00*
Timetable: From 南方莊園 to 高鐵桃園站 *08:30, 09:20, 11:00, 12:20*

C.【搭乘 FUZZY 2018 提供之免費接駁車】會議期間，FUZZY2018 提供免費接駁巴士，請至高鐵桃園站之**五號出口**搭乘。

Timetable: From 高鐵桃園站 to 南方莊園 *Nov. 5, Nov. 6 == 8:30, 12:00*
Timetable: From 南方莊園 to 高鐵桃園站 *Nov. 5, Nov. 6 == 17:20, 21:00*

2.【台鐵中壢站==會場】

A.【計程車】由台鐵中壢站至會場, 單程計程車費用約 NT$180 (此為預估車資)

B.【南方莊園接駁服務】接駁車僅提供**住宿客人**於住宿期間，定時定點免費接駁服務。接駁地點為高鐵桃園站(同機場捷運 A18 高鐵桃園站)，及中壢火車站。若須定時以外時間接駁，單趟收費$400 元，搭乘人數 8 位。接駁車採**事先預約制**，請於搭車前一日 17:00 前向飯店登記預約。

Timetable: From 中壢站 to 南方莊園 *15:20, 16:40*
Timetable: From 南方莊園 to 中壢站 *10:10, 11:30*

3.【自行開車】中山高下中壢/新屋交流道，沿縣道 114 往西行，過中平國小，右轉直行即可抵達南方莊園渡假飯店。

會議議程表

Typographical conventions:
CACS – The 2018 International Automatic Control Conference
FUZZY – The 26th National Conference on Fuzzy Theory and Its Applications
MOST – Final Presentation of MOST Grants
TASSE – Taiwan Association of Systems Science and Engineering

November 5, 2018 (Monday)		
08:00 |	**註冊** **地點：會議大廳**	
09:20 | **10:30**	**開幕式** Plenary Speech I Professor Dong-Il (Dan) Cho ***"Ion Control in MEMS Traps for Quantum Information"*** 地點：艾菲爾廳	
10:30 | **10:45**	Tea Break 地點：會議大廳	
10:45 | **12:00**	Plenary Speech II Professor Bor-Sen Chen ***"Multiobjective H2/H∞ Control Design of the Nonlinear Mean-Field Stochastic Jump-Diffusion Systems via Fuzzy Approach"*** 地點：艾菲爾廳 主持人：Professor Chin-Wang Tao	
12:00 | **13:00**	**中餐**	CACS BOG Meeting 地點：里昂廳 E
13:00 | **15:30**	Panel Sessions CACS 2018	MOST Poster 地點：會議大廳
15:30 | **15:50**	Tea Break 地點：會議大廳	
15:50 | **17:05**	Panel Sessions CACS 2018	**FUZZY Poster-I** **地點：會議大廳**
17:05 | **18:00**	Panel Sessions CACS 2018	

November 6, 2018 (Tuesday)			
09:00 | 10:30	Panel Sessions CACS 2018	**FUZZY 最佳學生論文競賽** **地點：里昂廳 E**	MOST Poster 地點：會議大廳
10:30 | 10:45	**Tea Break** **Place: Conference Foyer**		
10:45 | 12:00	Panel Sessions CACS 2018	**FUZZY 最佳論文競賽** **地點：里昂廳 E**	**FUZZY Poster-II** **地點：會議大廳**
12:00 | 13:00	**中餐**	**模糊學會會員大會** **FUZZY 頒獎** **地點：艾菲爾廳**	TASSE BOG Meeting 地點：里昂廳 D
13:00 | 14:15	**AI Forum** 地點：艾菲爾廳		
14:15 | 15:30	Plenary Speech III Professor Fumitoshi Matsuno ***"Bioinspired Robotics and Its Application to Rescue and Recovery"*** 地點：艾菲爾廳		
15:30 | 15:50	**Tea Break** **Place: Conference Foyer**		
15:50 | 17:05	Annual General Meeting of Chinese Automatic Control Society 地點：艾菲爾廳	MOST Poster 地點：會議大廳	CACS Poster 地點：會議大廳
17:05 | 18:00	**Welcome Speech from Discipline Coordinator of MOST Control Engineering Program** Professor Chun-Liang Lin 地點：艾菲爾廳		
18:10 |	**晚宴** 地點：凡爾賽廳		

論文發表議程

FUZZY Poster-I Nov. 5, 15:50-17:05, 地點：會議大廳						
論文編號						
#1001	**#1002**	**#1007**	**#1008**	**#1012**	**#1013**	**#1015**
#1016	**#1019**	**#1020**	**#1021**	**#1032**	**#1042**	**#1044**
#1045	**#1048**	**#1051**	**#1054**	**#1058**	**#1060**	
FUZZY 最佳學生論文競賽 Nov. 6, 09:00-10:30, 地點：里昂廳 E						
論文編號						
#1003	**#1005**	**#1027**	**#1029**	**#1034**	**#1046**	**#1052**
FUZZY 最佳論文競賽 Nov. 6, 10:45-12:05, 地點：里昂廳 E						
論文編號						
	#1023	**#1035**	**#1043**	**#1047**	**#1050**	
FUZZY Poster-II Nov. 6, 10:45-12:05, 地點：會議大廳						
論文編號						
#1004	**#1006**	**#1009**	**#1010**	**#1011**	**#1022**	**#1024**
#1025	**#1026**	**#1028**	**#1030**	**#1031**	**#1036**	**#1037**
#1038	**#1039**	**#1040**	**#1041**	**#1049**	**#1053**	**#1055**
#1056	**#1057**	**#1059**				

- **POSTER 論文發表**：請於指定發表時間前 10 分鐘完成海報張貼。
- **最佳學生論文競賽 & 最佳論文競賽**：每篇論文報告(PPT)時間為 10 分鐘，以及 3 分鐘的問題討論。會場備有筆記型電腦以及投影機。

論文列表

最佳學生論文競賽

SESSION CHAIR: 陶金旺教授、陳美勇教授

最佳論文競賽

SESSION CHAIR: 李祖聖教授、莊家峰教授

Regular Session

REGULAR PAPER

Special Session 1

智慧型系統的應用與實現

SESSION ORGANIZER: 莊鎮嘉教授

Special Session 2

智慧型控制系統

SESSION ORGANIZER: 陶金旺教授

Special Session 3

人工智慧與智慧型計算之應用

SESSION ORGANIZER: 潘欣泰教授

SESSION CO-ORGANIZER: 吳志宏教授、洪宗貝教授

Special Session 4

網路通訊與物聯網系統

SESSION ORGANIZER: 高誌陽教授

SESSION CO-CHAIR: 洪東興教授

Special Session 5

物聯網應用

SESSION ORGANIZER: 徐昌鴻教授

SESSION CO-ORGANIZER: 周智倫教授

Special Session 6

智慧型系統

SESSION ORGANIZER: 鄭錦聰教授

Special Session 7

智慧型機器人系統

SESSION ORGANIZER: 許駿飛教授

Special Session 8

資料驅動計算智慧技術與應用

SESSION ORGANIZER: 莊家峰教授

SESSION CO-ORGANIZER: 林正堅教授

Special Session 9

機器人與機器視覺之應用

SESSION ORGANIZER: 陳美勇教授

SESSION CO-ORGANIZER: 陳俊達教授

論文摘要

最佳學生論文競賽

#1003 應用深度學習於資訊安全風險評鑑

張力允、李仁鐘

日新月異的科技進步，直接影響了人們在資訊 上之使用，在這樣的環境下，組織應如何保護資訊 使用中的安全，一直都是非常重要的議題，資訊安 全最主要保護之三元素是：機密性(Confidentiality)、 完整性(Integrity)及可用性(Availability)。 資訊安全管理上，風險評鑑是非常關鍵的一項 活動，現今的風險評鑑活動大多是以人工方式進行， 評估過程可能會較主觀，本論文將使用決策樹、支 援向量機、線性迴歸及深度學習進行資料分析，將 人工評估出來之結果進行資料整理後，利用上述四 種方法進行資料分析，並將這四種資料分析所得到 之結果進行比較，實驗結果得知，深度學習可以得 到最佳正確率，因此，本論文提出應用深度學習於進行資訊安全風險評鑑。

關鍵詞：資訊安全、風險評鑑、決策樹、支援向量 機、線性迴歸、深度學習

The rapid advancement of science and technology has directly affected people's use of information. Under such circumstances, how organizations should protect the security of information has always been a very important issue. The three main elements of information security are: Confidentiality, Integrity and Availability. In information security management and risk assessment is a very critical activity. Most of the current risk assessment activities are conducted manually. The assessment process may be comparatively subjective. This dissertation will use decision tree, support vector machine, linear regression, and deep learning to conduct data analysis, and then manually review the results of the assessment. Using the above four methods for data analysis, experimental results deep learning gets the optimal accuracy. This dissertation proposes applying deep learning to the information security risk assessment.

Keywords: Information Security, Risk Assessment, Decision Tree, Support Vector Machine, Linear Regression, Deep Learning

#1005 應用模糊均值法及類神經網路於低壓用電戶之用電量分析

黃彥傑、楊柏遠、曲晉逸、蔡進聰、周至宏

本文使用模糊均值法 (Fuzzy C-means Method, FCM) 與類神經網路 (Artificial Neural Network, ANN) 針對用電資料進行分析及建模。在本文中，將用戶的用電資料依照春、夏、秋、冬區分，作為分析及評估的取樣時段；接著，利用FCM歸類出不同用戶的用電量，同時，收集最靠近該地區之氣象站所提供之氣溫與相對溼度資料，再將FCM分析後的資料放入ANN中，進行建模預測。ANN訓練建模時，可透過調整參數得到較好的訓練結果。最後，利用相關係數 (R值) 來判定建模的結果。從結果來看，除用電量較大的類別於春夏兩季及較小類別於秋季在建模成效上，表現略差外，其餘部分R值皆落在相關係數高及相關係數良好的數值。

關鍵詞：模糊均值法，類神經網路，相關係數

This paper uses fuzzy c-means method (FCM) and artificial neural networks (ANNs) to analyze and model for low-voltage electricity data. In the first step, this paper divides the data into four parts due to seasons. Second, each group are distinguished by FCM to several clusters. At the same time, weather information, including temperature and relative humidity, near consumers' area is collected. After distinguishing by FCM, the clusters of the data are modeling and analysis by ANN. In here, the performance of the model is determined by correlation coefficient (R-value).

Keywords: Fuzzy c-means method, Artificial neural network, Correlation coefficient

#1027 **利用模糊系統設計兩輪平衡機器人之重心補償器**

高瑋甫、許駿飛、李祖添

本論文基於模糊系統設計提出了一個重心補償器。為了驗證所設計平衡控制器及重心補償器之效能，本論文規劃了一個任務場景實驗，當機械手臂做一些動作姿態改變的時候，觀察重心補償器的效果，經由實測結果驗證所設計的控制系統及重心補償器均可以獲得良好的效果，而且重心補償器成功地克服機械手臂姿態改變之所造成的機器人重心影響。

關鍵詞：兩輪平衡機器人、平衡控制、機械雙臂、模糊系統、重心補償。

#1029 **Fuzzy Control for Discretized Ship Steering Systems with Multiple Performance Requirements**

林彥宏、張文哲

This paper presents a robust fuzzy controller design method for nonlinear systems based on Takagi-Sugeno fuzzy model. Firstly, the state variance constraint is considered for the performance under the effect of stochastic behaviors. Secondly, the pole placement theory is considered for the transient behaviors of time response. Then, it can be combined with each other by the controller design method in this paper. Besides, the perturbations of system state and input are considered, which can be solved by robust control theory. Therefore, the sufficient stability conditions can be obtained by Lyapunov theory. Then, the stability conditions are effectively solved by recasting into so-called linear matrix inequality problems. At last, a simulation is provided for the nonlinear ship steering system.

Keywords: Takagi-Sugeno fuzzy model, robust control, state variance constraint, pole placement constraint

#1034 **應用模糊推論於線上學習專注度評分之視線追蹤系統**

高子祺、林志瓏、林鈺琴、孫宗瀛

隨著科技的發展，網路與個人電腦普及程度提 高，線上學習亦隨之成為趨勢，然而長時間專注於 課程學習實屬難事。因此，利用學習者的視線專注 區塊以了解學習狀況，已成為相當熱門的議題。本 研究提出以視線追蹤為基礎的學習者專注評分系 統，利用3D 攝影機擷取頭部姿態，進行眼睛追蹤、 瞳孔位置偵測，並以模糊推論推斷學習者的視線區 塊，與學習視窗比對，執行學習專注度評分。

關鍵詞：視線偵測、眼部追蹤、瞳孔輪廓、模糊系統。

#1046 **Rapid Identification of Friction of Feed Drive Systems for Machine Tools**

Ching-Hung Lee and Ko-Fei Lee

在精密加工上，進給系統之摩擦力常造成精度 下降現象，即使保持潤滑也僅能減少摩擦力大小，如能鑑別摩擦力並給予補償將可有效維持精度。本 文針對簡易摩擦力模型提出了一種 CNC 工具機的快速摩擦力鑑別方法。透過循圓軌跡測試，取得速 度響應進行摩擦力鑑別。在傳統摩擦力鑑別中，需 要耗費多時在實驗上，透過本文提出的方法可以減 少鑑別時間。

關鍵詞：鑑別、穩態摩擦力、工具機、進給系統。

In precision machinery, the fraction always results the worse accuracy. The accuracy can be maintained when the frication has been identification and compensated. In this study, we establish a simple friction model and proposed a rapid friction identification method for CNC machine tools. The frictional force is identified by the velocity data and current data of one set of circular trajectories. In the traditional friction identification, it takes a lot of time to experiment, and the method of our proposed method can reduce the identification time.

Keywords: Friction identification, steady-state frictional force, machine tools, feed drive system

#1052 Modified CoSaMP based on Artificial Bee Colony Algorithm

Shun-Hung Tsai and Wei-Cheng Zheng

本論文提出一種改進的演算法，將壓縮取樣匹 配與人工蜂群演算法結合，使用人工蜂群演算法取代壓縮取樣匹配中的貪婪演算法，從測量矩陣中選 擇具相關性的組成。實驗結果表示，本論文提出的 演算法有更好的還原品質，更高的峰值訊號雜訊比 及結構相似性。

關鍵詞：壓縮感知、人工蜂群演算法。

In this paper, we propose a novel algorithm which combines the compressive sampling matching pursuit (CoSaMP) and the artificial bee colony (ABC) algorithm. We replace the greedy algorithm in CoSaMP with artificial bee colony algorithm to select the related components from the measurement matrix. The experiment shows that the proposed algorithm can provide the better recovery quality, higher peak signal-to-noise ratio (PSNR) and structural similarity (SSIM).

Keywords：compressive sensing, artificial bee colony

最佳論文競賽

#1023 **Finding Main Causes of Juvenile Scoliosis by Fuzzy Analytic Network Process**

Yo-Ping Huang, Avichandra Singh, and Li-Ju Lai

Adolescent idiopathic scoliosis (AIS) is one of the most common spinal deformities found in adolescent populations. The etiology and pathogenesis of AIS remain unclear. Although many abnormalities concomitant to AIS have been described the etiology behind AIS remains inconclusive. To investigate and intervene in this health concern at an earlier stage, we aim to systematically review and synthesize available studies on AIS abnormalities. We conducted extensive scoliosis examinations on students in many elementary schools. During the examinations, not only the scoliosis was examined but also questionnaires were issued to students to understand how their daily habits related to the body posture. In our research, we also use information gain and gain ratio to find out the important attributes of scoliosis of juvenile. Then, we apply fuzzy analytical network process (FANP) to rank attributes from the most to the least related factors to scoliosis. Finally, we extract association rules among the selected attributes. Findings of this study reveal a new perspective on the treatment of scoliosis for elementary school students at the early stage and prevention from the worsened condition in adolescence.

Keywords: fuzzy analytical network process (FANP); scoliosis; analytic hierarchy process (AHP); information gain

#1035 **Using Fuzzy Sets to Speed up the Optimization of Group Stock Portfolio**

Bing-Yang Chian, Chun-Hao Chen, and Tzung-Pei Hong

In this paper, a new chromosome representation and an enhanced fitness function are applied to find a better diverse group stock portfolio (DGSP) with lower risk than before; moreover, we design a fuzzy grouping genetic algorithm (FGGA) which utilizes fuzzy logic to dynamically tune the parameters in the evolution process for finding appropriate DGSPs. In addition, a mechanism is also designed in the proposed approach to repair non-eligible chromosomes in the population. Finally, experiments made on a real dataset also show that the proposed approach is effective and efficient.

Keywords: diverse group stock portfolio, fuzzy grouping genetic algorithm, grouping problem, individual repair mechanism, portfolio optimization.

#1043 **Intelligent Integral Terminal Sliding-Mode Consensus Tracking Control Using ORFWNN for Uncertain Networking Second-Order Nonlinear Multi-Agent Systems**

Hsiao-Lang Wu and Ching-Chih Tsai

This paper presents an intelligent integral terminal sliding-mode (ITSM) consensus tracking control using output recurrent fuzzy wavelet neural networks (ORFWNN) for a class of networking second-order nonlinear multi-agent systems (NMASs) with uncertainties. Each uncertain NMAS is described by a second-order state equation with uncertainties and the multi-agent system is modeled by directed graph theory. By using the ITSM control theory and online learning with ORFWNNs, an intelligent ITSM consensus tracking control approach using ORFWNNS is presented to achieve consensus tracking control in presence of uncertainties. A simulation is conducted to show the effectiveness and merits of the proposed method.

Keywords: Consensus tracking control, integral terminal sliding-mode (ITSM) control, second order nonlinear multi-agent system (NMAS), output recurrent fuzzy wavelet neural networks (ORFWNN).

#1047 **A Recurrent Fuzzy Neural Network-Based Adaptive Coupling Control for Multi-Axis Systems**

Bo-Sheng Chen and Ching-Hung Lee

本文我們提出基於遞迴模糊神經網絡 之自適應耦合控制器最小化輪廓誤差。為了減少輪 廓誤差，我們通過將動態系統轉換為輪廓誤差座 標。考慮線馬系統存在時變的非線性現象，為了解 決此時變問題，在本文利用具有時間因子之動態網 路遞迴模糊類神經進行估測時變非線性項，透過系 統參數更新以及遞迴模糊神經系統補償系統參數 之不確定性以及非線性現象減少輪廓誤差。更新式 與控制器的穩定性皆透過李亞普諾夫(Lyapunov)定 理獲得。最後利用模擬說明控制器能有效解決系統 非線性現象。

關鍵詞：遞迴模糊類神經，自適應性，輪廓誤差。

In this study, we introduce a recurrent fuzzy neural network (RFNN)-based adaptive coupling controller for multi-axis system to minimize the contour error. The considered system is transferred into nonlinear time-varying system due to the time-dependent coordinate transformation. Herein, we propose an adaptive model-based coupling controller design for multi-axis linear motor system with uncertainty and nonlinear phenomena. The stability of closed-loop system is guaranteed by Lyapunov method and the adaptation of RFNN is also obtained. Simulation results are introduced to illustrate the effectiveness.

Keywords: Adaptive control, coupling, multi-axis systems, recurrent fuzzy neural network

#1050 **應用樹狀結構探勘模糊高效益項目集**

洪宗貝、林承郁、黃偉銘、李淑敏、林浚瑋

資料探勘為從資料庫中擷取出有用知識的重 要過程，目前廣泛應用在金融、科學等眾多領域上。在計算智慧研究上，模糊集合論因為其概念簡單且 類似於人類思考推理，長久以來一直被使用在許多 智慧型系統上。而近年來有一些模糊資料探勘演算 法結合上述兩門技術的優點而被設計出來，並在某 些領域上有好的效果。在本論文中，我們規劃研究 一個深具挑戰但具實用性的模糊探勘議題，稱為模 糊效益探勘，此議題同時考慮了項目的購買數量、 利潤及人類購買行為時容易了解的語詞意義。我們 設計樹狀結構的模糊高效益上界量測方法，能提供 向下封閉的特性，並且探勘出完整模糊高效益項目 集。透過實驗可得知，我們的方法相對的與先前相比可減少執行時間。

關鍵詞：資料探勘、模糊集合、模糊效益探勘、樹狀結構

REGULAR SESSION

#1005 應用模糊均值法及類神經網路於低壓用電戶之用電量分析

黃彥傑、楊柏遠、曲晉逸、蔡進聰、周至宏

本文使用模糊均值法 (Fuzzy C-means Method, FCM) 與類神經網路 (Artificial Neural Network, ANN) 針對用電資料進行分析及建模。在本文中，將用戶的用電資料依照春、夏、秋、冬區分，作為分析及評估的取樣時段；接著，利用FCM歸類出不同用戶的用電量，同時，收集最靠近該地區之氣象站所提供之氣溫與相對溼度資料，再將FCM分析後的資料放入ANN中，進行建模預測。ANN訓練建模時，可透過調整參數得到較好的訓練結果。最後，利用相關係數 (R值) 來判定建模的結果。從結果來看，除用電量較大的類別於春夏兩季及較小類別於秋季在建模成效上，表現略差外，其餘部分R值皆落在相關係數高及相關係數良好的數值。

關鍵詞：模糊均值法，類神經網路，相關係數

This paper uses fuzzy c-means method (FCM) and artificial neural networks (ANNs) to analyze and model for low-voltage electricity data. In the first step, this paper divides the data into four parts due to seasons. Second, each group are distinguished by FCM to several clusters. At the same time, weather information, including temperature and relative humidity, near consumers' area is collected. After distinguishing by FCM, the clusters of the data are modeling and analysis by ANN. In here, the performance of the model is determined by correlation coefficient (R-value). From experimental results, all of models are obtained good or excellent R-value unless the group of more consumption in spring and summer, and less consumption in fall.

Keywords: Fuzzy c-means method, Artificial neural network, Correlation coefficient.

#1010 神經網路應用於人體全髖骨骨密度預測之研究

洪暐傑、楊智惠、蕭介夫、陳益君、黃瑞初

本研究以神經網路為方法，進行人體全髖骨骨密度(Total hip bone mineral density)的預測研究。研究分析樣本為2010年田寮地區男性368位之健檢資料為主，年齡分佈範圍為65歲~98歲。為使研究具有客觀性，我們以隨機選取方式，將原資料368筆順序重組成五組資料，每一組資料，我們以278筆資料做為神經網路學習之用，90筆資料則做為測試之用。研究結果發現，五組神經網路訓練的平均絕對百分比誤差為5.79%，測試的平均絕對百分比誤差則為5.94%，意即無論在訓練與測試資料上，神經網路應用於人體全髖骨骨密度的預測準確率可達94%以上，由此證明神經網路於醫療照護上應用有極大的可行性與優越性。

關鍵詞: 神經網路、全髖骨骨密度、預測

This paper presents the prediction of the total hip bone mineral density by using neural network (NN). The study samples were collected from 368 male physical examinations in Tianliao district, 2010. And, the age range is between 65 to 98 years old. In order to make the research could be more objective, we randomly reorganized the original 368 data into five groups. For each data group, 278 data are used for NN's learning and 90 data are used for NN's testing. In the studies, we found that the average of MAPEs (mean absolute percentage errors) of five NNs training and testing data sets are 5.79% and 5.94%, respectively. It also means that the prediction accuracy of hip bone mineral density by NN model could reach to 94% in the training and test data. In other words, the NN technique do have the great feasibility and superiority in medical care applications.

Keywords: neural network, hip mineral bone density, prediction

#1011 神經網路應用於股骨頸T評分之預測

洪暐傑、楊智惠、蕭介夫、張浚格、黃瑞初

骨質密度（Bone mineral density）的檢查，一般認定是簡要評估骨質健康狀況的快速方法，而T數值(T-score)在醫療上被作為骨質疏鬆症的診斷依據。本研究以神經網路為方法，進行人體股骨頸T評分的預測研究。研究分析樣本為2009年田寮地區333位女性之健檢資料為主，年齡分佈範圍為65歲~94歲。在研究中，我們以258筆資料做為神經網路訓練之用，75筆資料則做為網路測試之用。研究結果發現，四組神經網路訓練的平均絕對百分比誤差為4.52%，測試的平均絕對百分比誤差則為4.89%，平均而言，神經網路應用於股骨頸T評分的預測準確率達95%以上，由研究結果顯示，神經網路於醫療上的應用有著極大的潛力與價值。

關鍵詞: 神經網路、T評分、預測

It is known that the examination of bone mineral density (BMD) is a simple and quick method for evaluating the health of bone. The T-score is used to be the diagnostic criteria of osteoporosis in medicine. In this research, the neural network is applied to predict the T-score of femoral neck. The study samples were collected from 333 female physical examinations in Tianliao district, 2009. The age range of the samples is between 65 to 94 years old. In 333 examination data, 258 data are used for NN's training and 75 data are used for NN's testing. In our studies, we found that the average of mean absolute percentage errors (MAPEs) of four NNs training and testing data sets are 4.52% and 4.89%, respectively. In average, the prediction accuracy of hip neck BMD by NN model could reach to 95% more. The study result shows that the NN technique indeed has the great potential and superiority in the medical cares.

Keywords: neural network, T-score, prediction

#1012 基於方向梯度直方圖之類神經網路的人臉影像情緒辨識研究

黃柏翰、溫博浚

本研究為提出一種基於方向梯度直方圖(Histogram of oriented gradient, HOG)之類神經網路(Neural Network, NN)的人臉影像情緒辨識方法。本研究透過檢測人臉的眼睛與鼻子並提取出HOG特徵值，接著透過HOG特徵值於類神經網路與支持向量機(Support Vector Machine, SVM)進行人臉情緒辨識。其人臉情緒辨識結果顯示，類神經網路為77%的辨識率，而SVM為72%的辨識率，相比之下，類神經網路具有更好的情緒辨識率。因此，基於HOG的神經網路比起SVM更適合用於人臉影像情緒識別。

關鍵詞：方向梯度直方圖，類神經網路，支持向量機。

This study proposes a facial image emotion recognition method based on a Histogram of oriented gradient (HOG) with neural network. This study detects facial features from the eyes and nose to extract the HOG features. Facial emotions of the face is identified by neural network and Support Vector Machine (SVM) based on the HOG features. Compared to the emotion recognition rate of neural networks and SVM, the recognition-rate result of 77% based on neural network is better than the results of 72% based on SVM. Therefore, neural networks based on HOG is more suitable than SVM for facial image emotion recognition.

Keywords: Histogram of oriented gradient(HOG), Neural Network(NN), Support Vector Machine (SVM).

#1023 **Finding Main Causes of Juvenile Scoliosis by Fuzzy Analytic Network Process**
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Adolescent idiopathic scoliosis (AIS) is one of the most common spinal deformities found in adolescent populations. The etiology and pathogenesis of AIS remain unclear. Although many abnormalities concomitant to AIS have been described the etiology behind AIS remains inconclusive. To investigate and intervene in this health concern at an earlier stage, we aim to systematically review and synthesize available studies on AIS abnormalities. We conducted extensive scoliosis examinations on students in many elementary schools. During the examinations, not only the scoliosis was examined but also questionnaires were issued to students to understand how their daily habits related to the body posture. In our research, we also use information gain and gain ratio to find out the important attributes of scoliosis of juvenile. Then, we apply fuzzy analytical network process (FANP) to rank attributes from the most to the least related factors to scoliosis. Finally, we extract association rules among the selected attributes. Findings of this study reveal a new perspective on the treatment of scoliosis for elementary school students at the early stage and prevention from the worsened condition in adolescence.

Keywords— fuzzy analytical network process (FANP); scoliosis; analytic hierarchy process (AHP); information gain

#1035 **Using Fuzzy Sets to Speed up the Optimization of Group Stock Portfolio**
Bing-Yang Chian , Chun-Hao Chen, and Tzung-Pei Hong

In this paper, a new chromosome representation and an enhanced fitness function are applied to find a better diverse group stock portfolio (DGSP) with lower risk than before; moreover, we design a fuzzy grouping genetic algorithm (FGGA) which utilizes fuzzy logic to dynamically tune the parameters in the evolution process for finding appropriate DGSPs. In addition, a mechanism is also designed in the proposed approach to repair non-eligible chromosomes in the population. Finally, experiments made on a real dataset also show that the proposed approach is effective and efficient.

Keywords ： diverse group stock portfolio, fuzzy grouping genetic algorithm, grouping problem, individual repair mechanism, portfolio optimization.

#1046 **Rapid Identification of Friction of Feed Drive Systems for Machine Tools**
Ching-Hung Lee and Ko-Fei Lee

在精密加工上，進給系統之摩擦力常造成精度 下降現象，即使保持潤滑也僅能減少摩擦力大小，如能鑑別摩擦力並給予補償將可有效維持精度。本 文針對簡易摩擦力模型提出了一種 CNC 工具機的快速摩擦力鑑別方法。透過循圓軌跡測試，取得速 度響應進行摩擦力鑑別。在傳統摩擦力鑑別中，需 要耗費多時在實驗上，透過本文提出的方法可以減 少鑑別時間。

關鍵詞: 鑑別、穩態摩擦力、工具機、進給系統。

In precision machinery, the fraction always results the worse accuracy. The accuracy can be maintained when the frication has been identification and compensated. In this study, we establish a simple friction model and proposed a rapid friction identification method for CNC machine tools. The frictional force is identified by the velocity data and current data of one set of circular trajectories. In the traditional friction identification, it takes a lot of time to experiment, and the method of our proposed method can reduce the identification time.

Keywords ： Friction identification, steady-state frictional force, machine tools, feed drive system

#1047 A Recurrent Fuzzy Neural Network-Based Adaptive Coupling Control for Multi-Axis Systems

Bo-Sheng Chen and Ching-Hung Lee

本文我們提出基於遞迴模糊神經網絡 之自適應耦合控制器最小化輪廓誤差。為了減少輪 廓誤差，我們通過將動態系統轉換為輪廓誤差座 標。考慮線馬系統存在時變的非線性現象，為了解 決此時變問題，在本文利用具有時間因子之動態網 路遞迴模糊類神經進行估測時變非線性項，透過系 統參數更新以及遞迴模糊神經系統補償系統參數 之不確定性以及非線性現象減少輪廓誤差。更新式 與控制器的穩定性皆透過李亞普諾夫(Lyapunov)定 理獲得。最後利用模擬說明控制器能有效解決系統 非線性現象。

關鍵詞：遞迴模糊類神經，自適應性，輪廓誤差。

In this study, we introduce a recurrent fuzzy neural network (RFNN)-based adaptive coupling controller for multi-axis system to minimize the contour error. The considered system is transferred into nonlinear time-varying system due to the time-dependent coordinate transformation. Herein, we propose an adaptive model-based coupling controller design for multi-axis linear motor system with uncertainty and nonlinear phenomena. The stability of closed-loop system is guaranteed by Lyapunov method and the adaptation of RFNN is also obtained. Simulation results are introduced to illustrate the effectiveness.

Keywords: Adaptive control, coupling, multi-axis systems, recurrent fuzzy neural network

#1048 A New Improved Training Algorithm for Fuzzy Neural Networks within its Updated Capacity Bounds

Chi-Hsu Wang and Kar Chun Hor

這篇論文首先討論並且更新模糊類神經網絡的容量上限。如果訓練數據量在模糊類神經網絡的容量範圍內，該網絡可以幾乎零誤差的記住所有的訓練數據。但是這個現象必須是在該網絡有完整的訓練的情況之下，否則不一定保證可達到很好的收斂效果，甚至發散。故此論文提出一新的模糊類神經的訓練方法，可以有效且完整的訓練模糊類神經網絡，來保證在其容量範圍內時訓練得以收斂。本論文採用鳶尾花數據集做分類驗證，並得到良好的訓練效果以及驗證了新的模糊類神經之容量範圍。

關鍵詞：模糊類神經網絡，模糊系統，模糊類神經網絡之容量範圍，動態最佳化訓練法，倒傳遞演算法，鳶尾花數據。

In this paper, the upper bound of FNNs (Fuzzy Neural Networks) capacity found in other papers will be revised first. We know that FNN can memorize all the training patterns without error if the number of training patterns is within its capacity bound. However, this can only be validated by a proper complete training algorithm. A new improved training algorithm for FNN is therefore proposed to further validate its updated capacity bound, which will be illustrated in details with examples. The well-known Iris dataset for classification problem is adopted as the benchmark test, with excellent training performance.

Keywords：Fuzzy Neural Networks, Fuzzy Systems, Capacity of Fuzzy Neural Networks, Dynamic Optimal Training Algorithm, Backpropagation Algorithm, Iris Dataset.

#1057 **Cooperative Localization Using Fuzzy DDEIF and Broad Learning System for Uncertain Heterogeneous Omnidirectional Multirobots**

Chung-Wei Wu and Ching-Chih Tsai

This paper presents a fuzzy distributed and decentralized extended information filtering (FDDEIF) method with broad learning system (BLS) for indoor cooperative localization of heterogeneous omnidirectional mobile robots (HOMRs) where the communication topology is not fully connected. The BLS is proposed to online approximate the uncertain dynamic vectors in the dynamic model of any HOMR. A pose initialization algorithm is proposed to estimate the robot's initial position and orientation. Once all the initial gestures of the robot are roughly determined, A FDDEIF method together with the BLS is presented to fuse the sensor's measurement information for estimating more accurate posture of each HOMR. This experimental system uses a RGBD sensor mounted on a robot to detect known landmarks and a laser sensor to detect the surroundings. Simulations are conducted to show that the proposed method is effective in finding accurate pose estimation of three cooperative HOMRs with unknown initial poses.

Keywords: Cooperative localization, broad learning system (BLS), fuzzy distributed and decentralized extended information filtering (FDDEIF), multirobots, heterogeneous omnidirectional mobile robot (HOMR).

#1060 **運用模糊分類系統於學生課程預警之研究**

王金龍、趙群、莊舒媛、羅雅亭、洪珮真

現今全世界的高等教育在進行教學的過程 中，有相當大的比例使用數位教學平台，使得教學 與學習不再受到上課的時間所限，並且提高學生的 學習興趣，使教師更能掌握學生學習的狀況，進而提升學習成效。其中，最為可貴的是在數位教學平 台上，以學習活動日誌資料的方式，完整地記錄學 生在整學期中的學習脈絡。 本研究為使學生的學習成果表現的預測能夠 更加精確，提出模糊分類系統(Fuzzy Rule-Based Classification System, FRBCS)的演算法，包括二個階段：學習階段(learning phase)和預測階段(prediction phase)。本研究是依前學期學生於課程的學習活動進行建模，以次學期學生於課程的學習活 動進行預測，經過三項步驟的處理，包括(1)模糊化 機構(fuzzifier)、(2)模糊推論引擎(fuzzy inference engine)、以及(3)去模糊化機構(defuzzifier)，以期提 升學生的預測率。 研究結果發現透過模糊分類系統進行預測，其 準確率優於傳統決策樹之準確率。

關鍵詞：Moodle、學習預警、模糊分類系統

Currently, most of the universities employ digital learning platforms in teaching process, so that teaching and learning are no longer limited by the time of class and students' motivation in learning is improved. Teachers can better master student learning status, which in turn improves students learning outcomes. Besides, the digital learning platform can record the learning context of the students throughout the semester in the way of learning activity log data. In order to make the prediction of students' learning outcomes more accurate, this paper proposes a fuzzy rule-based classification system (FRBCS), which includes two stages: learning phase and prediction phase. First, in the learning phase, according to the training activity of the students in the previous semester as the training case. Secondly, in the forecasting stage, the learning activities of the students in the second semester are used as test cases, which are processed to improve the predictive rate of students with poor learning outcomes through three steps, including (1) fuzzifier and (2) fuzzy inference engine (fuzzy inference Engine), and (3) defuzzifiers. The research result shows that the accuracy of prediction by fuzzy rule-based classification system is better than the traditional decision tree.

Keywords ： Moodle, learning warning prediction, fuzzy rule-based classification system

#1058 **Integrating soft set and fuzzy linguistic model to evaluate maintenance and operating decisions of training simulation systems**

Kuei-Hu Chang, Yung-Chia Chang, and Hsiang-Yu Chung

隨著高科技進展、資訊化時代的來臨，現代化 的戰爭型態亦日新月異不斷改變，高科技武器設計 漸趨精密，造價也日趨昂貴，以往藉由實兵實彈進 行訓練的方式，不但成本高且易產生人員傷亡。因 此，許多國家的軍事單位也逐漸以訓練模擬系統取 代部分實兵演訓，達成戰備訓練之目標。然而，雖 然已有相當多類型的訓練模擬系統應用在軍事環 境，但各式模擬器的訓練績效卻從未完整評估，再 加上各訓練模擬系統建置時間、功能、環境與實際 操作人員素質等變動因素，以及部分資訊的不完 整，都將增加訓練模擬系統績效評估之困難。為解 決上述問題，避免各項模擬訓練系統使用率過低或 閒置，造成訓練資源浪費，本研究整合層級分析 法、軟集合、模糊語意模型及重要績效度分析進行 訓練模擬系統整體績效評估，並運用重要績效度分 析之概念，同時考量訓練模擬系統所節省之成本與訓練安全之影響，期望藉由此研究發現促進訓練模 擬系統使用效益，避免浪費資源，並為後續應用和 分析提供數據，為了驗證本研究提出的方法，採用 訓練模擬系統績效評估的數值範例，並與 AHP 及 novel-AHP 排序技術進行數值結果的比較。結果證 實，本研究提出的方法不僅可以充分考慮專家提供 的問卷資訊，降低訓練模擬系統績效排序的重複 率，並且透過二維圖示提供管理者作為訓練模擬系 統有限資源分配的決策參考，進而提高整體投資效 益和訓練成效。

關鍵詞：軟集合、語意模糊、訓練模擬系統、2元 語意模糊模式、層級分析法、重要績效度分析。

The advancement of high technologies and the arrival of the information age have caused changes to the modern warfare; more technologically exquisite weapons are designed, increasing in cost and complexity. Training maneuvers with live ammunition are expensive and are prone to accidental casualties. Thus, the military forces of many countries have replaced partially real training drills with training simulation systems to achieve combat readiness. Although considerable types of training simulation systems are used in military settings, the training effectiveness has never been evaluated completely. In addition, differences in system set up time, functions, the environment, and the competency of system operators, as well as incomplete information have made it difficult to evaluate the performance of training simulation systems. To address the aforementioned problems, this study integrated analytic hierarchy process, soft set, and the fuzzy linguistic representation model to evaluate the performance of various training simulation systems. Furthermore, importance–performance analysis was adopted to examine the influence of saving costs and training safety of training simulation systems. The findings of this study are expected to facilitate applying military training simulation systems, avoiding wasting of resources (e.g., low utility and idle time), and providing data for subsequent applications and analysis. To verify the method proposed in this study, the numerical examples of the performance evaluation of training simulation systems were adopted and compared with the numerical results of an AHP and a novel AHP-based ranking technique. The results verified that not only could expert-provided questionnaire information be fully considered to lower the repetition rate of performance ranking, but a two-dimensional graph could also be used to help managers allocate limited resources, thereby enhancing the investment benefits and training effectiveness of a training simulation system.

Keywords: Soft set, Linguistic fuzzy, Training simulation system, 2-tuple fuzzy linguistic representation model, Analytic hierarchy process, Important-performance analysis.

SPECIAL SESSION 1
智慧型系統的應用與實現

#1001 **高密度-高開關頻率返馳式同步整流器**
吳桂東、王見銘

本文提出一個使用英飛凌功率 IPP086N10N3 MOSFET 和虹冠 Dr.SR 控制器，實現可以取代肖特基 二極體以獲得較高的效率，成為一個簡易的高密度 -高開關頻率返馳式同步整流器。

This thesis presents an Infineon IPP086N10N3 MOSFET and a Champion Dr.SR controller that can replace the Schottky diodes for higher efficiency and become a simple, high-density, high-switching frequency flyback synchronous rectifier.

Keywords：Flyback, Dr.SR

#1042 **應用於 90 度側臉之人臉特徵辨識與比對**
徐勝均、劉原呈、周彥宇

一般人臉辨識都是依據人的正臉來取得特徵值再進行辨識。本研究加以改進，由側臉90度輔助進行人臉之辨識，以增加人臉辨識之成功率，再進行人臉不同角度的比對。

關鍵字：OpenCV，分類器，正臉，側臉，辨識，比對。

In general, face recognition is to obtain the features based on one person's frontal face and then to recognize it. This study aims to improve the above case. Face recognition is assisted by adding a 90-degree side-view face recognition to increase the success rate of face recognition, and then the faces are compared at different angles.

Keywords: OpenCV, classfier, frontal face, side-view face, recognition, comparison.

#1051 **光纖接續點信號發射器設計概念**
李欽銘、劉茂陽

本文提出利用此種概念，設計一種即使不開啟 人手孔蓋也能得知箱涵內是否有光纖接續點之裝置(圖 1)。此裝置將結合 WDM、PoF 及 RFID 之概 念所組成。

關鍵詞：WDM、PoF(Power over Fiber)、RFID

This paper proposes to use this concept to design a device that can know whether there is a fiber connection point in the box culvert even if the manhole cover is not opened. (figure 1)This device will be combined with the concepts of WDM, PoF and RFID

Keywords: WDM, PoF (Power over Fiber), RFID

#1044 具血壓監測與即時通報功能之時尚保暖短圍巾設計

陳佩妤、黃建誠、陳松雄、陳文平

當天氣寒冷時頸部如何保暖以避免體溫散 失，對於降低因體溫急遽變化導致身體不適，甚至 高血壓病患因血管收縮而使引發心血管疾病，具有 良好效果。因此在天氣驟變的環境中如能提供民眾頸部的保暖外，並適時的監控血壓變化，以減少感 冒發生機會並降低心血管疾病發生機率是現今重要的醫療保健研發項目。 科技與時尚流行是二種截然不同的領域，現今 求新求變的創意設計，已儼然是世界的發展趨勢， 本文提出一種具基礎生理血壓監控的時尚短圍 巾，內建有電能加熱功能，它不僅可提供民眾頸部 的保暖，亦能透過短圍巾內的隱藏式血壓感測器隨 時監控穿戴者的血壓變化，當血壓發生異常變化時 能即時提出警訊，並透過藍芽模組傳遞至智慧手機 發揮主動提醒功能，避免使用者因外在氣候環境改 變，造成增加罹患心血管疾病的機率。

關鍵詞：血壓監測，短保暖圍巾，預冷保暖。

When the weather is cold, how to keep the neck warm to avoid loss of body temperature, to reduce physical discomfort caused by sudden changes in body temperature, and even high blood pressure patients with cardiovascular disease, causing cardiovascular disease, has a good effect. Therefore, in the environment of sudden changes in the weather, if the warmth of the neck is provided, and timely monitoring of blood pressure changes to reduce the chance of colds and reduce the incidence of cardiovascular disease is an important medical research and development project.

Technology and fashion are two very different fields. Nowadays, the creative design of seeking new changes has become the development trend of the world. This paper proposes a short fashion scarf with basic physiological blood pressure monitoring, built-in electric heating function. It not only provides warmth to the neck of the people, but also monitors the blood pressure changes of the wearer through the hidden blood pressure sensor in the short scarf. When the blood pressure changes abnormally, it can immediately alert and transmit through the Bluetooth module. To the smart phone to take the initiative to remind the function, to avoid users due to changes in the external climate, resulting in increased risk of cardiovascular disease.

Keywords：Blood Pressure Monitoring, Short Warm Scarves, Pre-cold Warm.

#1054 應用模糊控制器於人形機器人來回行走競賽

王宣喻、許珮筠、李宜勳

針對 FIRA HuroCup 來回快跑比賽，我們設計 小型人型機器人，進行短距離來回快跑動作， 所使用的機器人是利用 17 個 AI 馬達來驅動 關節及頭部。藉由樹莓派 3 進行影像的擷取、 處理、及判斷特定目標物的位置，再將決策的 動作命令由序列傳輸的方式傳送至 Arduino 動 作控制器元，達到控制機器人的動作。為了解 決在前進或後退時左右轉時不穩定性，我們使 用模糊控制理論 (Fuzzy Control Theory)來計 算質心偏移與轉動幅度，經由實驗證明確實能 夠提高穩定性。

關鍵詞：雙足機器人、模糊系統、影像處理

In this paper, we design a small-size humanoid robot for the FIRA HuroCup Sprint competition. The robot uses 17 AI robots to drive head rotation and joints rotation for the legs and arms. A Raspberry pi 3 (RP3) is applied to effectively captured and analyze images. After deciding moving-actions by the centroid of a pre-set object, the RP3 sends a message-package, containing the action and duration for the action, to an Arduino. Accordion the action, the Arduino sends a control package to the 17 AI motors to move the robot. Finally, experiments show improvement in the sprint competition.

Keywords: Humanoid Robot, fuzzy system, Image processing

SPECIAL SESSION 2
智慧型控制系統

#1004 雙足機器人斜坡運動之姿態控制

吳俊憲、陶金旺、張嘉文

論文研究目的在於 Dongbu Robot 仿人型雙足 機器人於站姿時之平衡動作，以及步行姿態時如何減少機器人傾斜之可能。本文所使用的機器人具有 19個自由度，其中左右髖部及腳踝各擁有兩個自由 度，透過這些馬達可以更獨立地調整姿態來適應外 部的地形變化及環境的干擾。而其中所使用的控制 板透過撰寫自由度更高的 Arduino MEGA 2560單晶 片微控制器取代原廠的控制器，並且加入了三軸陀 螺儀和三軸加速度計 MPU6050數位運動處理器 (Digital Motion Processor)用來測量機器人重心傾斜 的依據，而後藉由 MPU6050陀螺儀之數值計算補償 量，藉此來及時修正機器人姿態來達成穩定步態。

關鍵詞：雙足機器人、平衡控制、Arduino、陀螺儀

The purpose of the research is to balance the movement of the Dongbu Robot's humanoid bipedal robot when standing, and how to reduce the robot’s tilt when walking. The robot used in this article has 19 degrees of freedom, in which the left and right hips and ankles each have two degrees of freedom. Through these motors, the posture can be adjusted more independently to adapt to changes in the external terrain and environmental disturbances. The control board used therein replaced the original controller through the Arduino MEGA 2560 single-chip microcontroller with higher degree of freedom of coding, and added a three-axis gyroscope and a three-axis accelerometer MPU6050 Digital Motion Processor. It is used to measure the tilt of the robot's center of gravity, and then calculates the compensation amount by the value of the MPU6050 gyroscope. In order to achieve a stable gait, the robot's posture is corrected in a timely manner.

Keywords：Biped robot, Balance control, Arduino, Gyro

#1006 利用機械視覺實踐產線自動化

丁執中、陶金旺、張嘉文

隨著科技的發展，使用機械代替人力不再是天 方夜譚，如何實際運用這些科技將是本次研究討論 的問題。本研究為了替代生產線上的人力，解決產 品不符合預期的隨機傾斜角度，本文結合了傾斜角 度、位置辨識，提供機械手臂校正其位置與角度。 此方法可以有效的解決生產線上產品出現無法預期的旋轉或位移時，能夠使用機械手臂將其回歸到 預設的角度以及位置。

關鍵詞：影像辨識、視覺回授、偏斜校正。

With the development of science and technology, the use of machinery to replace manpower is no longer a fantasy. How to actually use these technologies will be a problem discussed in this study. In order to replace the manpower in the production line and solve the problem that the product does not meet the expected random tilt angle, this study combines the tilt angle, position identification, and provides the robot arm to correct its position and angle. This method can effectively solve the unpredictable rotation or displacement of the product on the production line, and can use the robotic arm to return it to the preset angle and position.

Keywords：Visual feedback, Image recognition, Skew correction.

#1028 **Design of PID Controller Using TSK-Type Recurrent Fuzzy Neural Network**
Hung-Ching Lu and Ming-Hung Chang

This paper presents a TSK-type recurrent fuzzy neural network (TRFNN) controller with back-propagation (BP) algorithm and its application in trajectory tracking of Permanent-Magnet Linear-Synchronous-Motor (PMLSM). The TRFNN controller combines the TSK-fuzzy logic and recurrent fuzzy neural network (RFNN). The TRFNN controller is applied to track the position of the PMLSM. The TRFNN controller is composed of a Proportional-Integral-Derivative (PID) controller and a TRFNN estimator with a back-propagation (BP) algorithm. The PID controller is the main controller to control the position of the PMLSM. The TRFNN estimator is used to on-line update parameters of the PID controller. The BP algorithm is applied to adjust the parameters of the TRFNN estimator via the gradient descent method. Finally, the results confirm that the proposed TRFNN controller can achieve favorable tracking performance.

#1029 **Fuzzy Control for Discretized Ship Steering Systems with Multiple Performance Requirements**
林彥宏、張文哲

This paper presents a robust fuzzy controller design method for nonlinear systems based on Takagi-Sugeno fuzzy model. Firstly, the state variance constraint is considered for the performance under the effect of stochastic behaviors. Secondly, the pole placement theory is considered for the transient behaviors of time response. Then, it can be combined with each other by the controller design method in this paper. Besides, the perturbations of system state and input are considered, which can be solved by robust control theory. Therefore, the sufficient stability conditions can be obtained by Lyapunov theory. Then, the stability conditions are effectively solved by recasting into so-called linear matrix inequality problems. At last, a simulation is provided for the nonlinear ship steering system.

Keywords：Takagi-Sugeno fuzzy model, robust control, state variance constraint, pole placement constraint

#1038 **Pole Placement Constraint for Nomoto's Ship Steering System with Polynomial Model**
Cheung-Chieh Ku, Chih-Yu Yen, and Hung-Pang Chung

本研究主要探討運用極點配置法於 Nomoto 船舶操舵系統之穩定性問題。根據目前船舶航行技術，當駛航於海面上，諸多因素如海波阻力以及擾動皆會使得船舶方向產生偏差，也因此船舶操舵安全成為近十年重要的議題。是故，設計一智慧型自動操舵控制器，是有其必要性及迫切性。為了達到此目的，本文對於真實系統之非線性特徵以及不確定性，採用多項式數學模型來表示;再者，利用兩種型式的李亞普諾夫方程式來討論擁有極點配置性能之多項式數學模型的穩定性問題。模擬結果顯示，此類擁有極點配置性能之控制器能於特定擾動中，引導船舶自動操舵。

關鍵詞：Nomoto 船舶操舵系統，多項式數學模型，增益調節控制，極點配置法

The main purpose of this paper is to discuss stability problem of Nomoto's ship steering systems subject to pole placement constraint. To achieve the purpose, a description as polynomial model is applied to represent nonlinearity or uncertainty of the considered system. Moreover, two cases as Lyapunov function are proposed to discuss the stability of the polynomial model and to achieve the pole placement constraint. Based on the proposed design methods, one can find that the positive definite matrix plays important role on discussing the pole placement. Furthermore, some sufficient conditions are derived via the proposed Lyapunov functions. Based on the derived conditions, a controller is designed such that the stability of Nomoto's ship steering systems is guaranteed under the assigned pole placement constraint. Finally, the simulation results are provided for demonstrating the usefulness of the designed method.

Keywords: Nomoto's Ship Steering Model, Polynomial Model, Gain-Scheduled Control Scheme, Pole-Placement Constraints.

#1039 Stability Analysis and Synthesis for Stochastic Multiple Systems Subject H_2/Passivity Performances

Cheung-Chieh Ku and Chia-Hsing Liang

本文討論了包含$H_2/Passivity$性能系統的穩定與穩定性。通常，系統的不確定性或非線性可以藉由多個子系統組成的模型來描述。對於該模型，H_2控制理論利用於最小化輸出能量並確保系統漸進穩定。此外被動理論應用於限制外部干擾對系統的影響。考慮到H_2控制理論和被動理論，本文提出了一個具有混合性能控制方案。為了得到充分條件，本文使用李亞普諾夫函數，通過求解推導出的充分條件，可以得到可行解以建立控制器使得系統的漸進穩定和混合性能在均方根時實現。最後，通過一個數值模擬驗證本文方法的有效性。

關鍵詞：隨機系統，複合模型，被動理論，H_2控制

This paper discusses the stability and stabilization problem stochastic systems subject to $H_2/Passivity$ performance. Generally, the systems with uncertainty or nonlinearity can be described via a model consisting of multiple sub-systems. For the model, the H_2 control theory is applied to minimize the output energy and to guaranteed asymptotical stability of the system. Besides, the passivity theory is employed to constrain the influence of the external disturbance on the system. Considering the H_2 control theory and passivity theory, the existing mixed performance control scheme is a special case of the proposed design method. To derive the sufficient conditions, the Lyapunov function is employed. By solving the derived conditions, the feasible solutions can be obtained to establish a controller such that the asymptotical stability and mixed $H_2/Passivity$ performance of the system are achieved in the mean square. Finally, one numerical simulation is applied to prove the effectiveness of the method in this paper.

Keywords: Stochastic Systems, Multiple Model, Passivity Theory, H2 Control.

#1040 物聯網應用於圖書館智慧運書車之設計與開發

陳佳翎、張嘉文、陶金旺

本論文將設計並實作一圖書館智慧運書車系統，取代傳統圖書館在管理方面，較耗人力的排序、歸還書本作業，提升現有圖書館的還書效率、節省人力成本。本文以一具有書架用來放置待還書本的手推車體，配備樹莓派鏡頭掃描書本ISBN條碼、紅外線偵測書架有無放置書本，與RFID掃描器用來掃描地板RFID標籤以定位運書車在圖書館的位置。運用物聯網的技術，將運書車系統的資訊，呈現在網頁操作介面，並結合蟻群最佳化演算法與A*搜尋演算法，以進一步獲得最佳還書路線。相較於傳統的圖書館管理員。透過此系統提供管理員規劃後的還書路線，可以大幅提升管理員的還書效率。

關鍵詞：物聯網、圖書館、樹梅派。

This paper design and implemented a library book trolley system, which aims to take the book circulation in libraries that often involves large amount of human labor. This paper proposed a book trolley with a camera that recognizes barcodes, infrared book detection, and RFID-based indoor positioning. With IoT technology, the information of the system is presented through a web-based user interface, along with ACO and A* search algorithms, to obtain the best route for circulation. It can be found that the system apparently raise the effectiveness of library clerks.

Keywords：IoT, Library, Raspberry Pi.

#1043 **Intelligent Integral Terminal Sliding-Mode Consensus Tracking Control Using ORFWNN for Uncertain Networking Second-Order Nonlinear Multi-Agent Systems**

Hsiao-Lang Wu and Ching-Chih Tsai

This paper presents an intelligent integral terminal sliding-mode (ITSM) consensus tracking control using output recurrent fuzzy wavelet neural networks (ORFWNN) for a class of networking second-order nonlinear multi-agent systems (NMASs) with uncertainties. Each uncertain NMAS is described by a second-order state equation with uncertainties and the multi-agent system is modeled by directed graph theory. By using the ITSM control theory and online learning with ORFWNNs, an intelligent ITSM consensus tracking control approach using ORFWNNS is presented to achieve consensus tracking control in presence of uncertainties. A simulation is conducted to show the effectiveness and merits of the proposed method.

Keywords: Consensus tracking control, integral terminal sliding-mode (ITSM) control, second order nonlinear multi-agent system (NMAS), output recurrent fuzzy wavelet neural networks (ORFWNN).

#1052 **Modified CoSaMP based on Artificial Bee Colony Algorithm**

Shun-Hung Tsai and Wei-Cheng Zheng

本論文提出一種改進的演算法，將壓縮取樣匹 配與人工蜂群演算法結合，使用人工蜂群演算法取 代壓縮取樣匹配中的貪婪演算法，從測量矩陣中選 擇具相關性的組成。實驗結果表示，本論文提出的 演算法有更好的還原品質，更高的峰值訊號雜訊比 及結構相似性。

關鍵詞：壓縮感知、人工蜂群演算法。

In this paper, we propose a novel algorithm which combines the compressive sampling matching pursuit (CoSaMP) and the artificial bee colony (ABC) algorithm. We replace the greedy algorithm in CoSaMP with artificial bee colony algorithm to select the related components from the measurement matrix. The experiment shows that the proposed algorithm can provide the better recovery quality, higher peak signal-to-noise ratio (PSNR) and structural similarity (SSIM).

Keywords：compressive sensing, artificial bee colony

#1053 **雙軸式追日系統於低照度環境之最大功率追蹤方法與研究**

陳俊宏、張嘉文、陶金旺

本文主要研究目的是在台灣東北部蘇澳地區陽光照度不佳環境下,利用薄膜式碲化鎘(CdTs)太陽能板(低照度下3W/mi即可發電)的特性,建置於雙軸式追日系統上,控制方面本文以(Arduino UNO)數位控制器搭配馬達驅動電路(L298N), 作為追日系統控制的神經中樞,實驗中與固定式太陽能板在相同環境下(日照、溫度、時間)作紀錄及轉換效能提升的百分比率統計,借以驗證在低照度環境下因其白天能產出電力時間較長,而實現最大發電功率的可能。

關鍵詞：碲化鎘(CdTe)、Arduino 數位控制器、雙軸式追日系統

The main purpose of this paper is to use the characteristics of thin film cadmium telluride (CdTs) solar panels (3W/m2 under low illumination) to build a biaxial-style chasing day under the illumination environment of northeastern Taiwan.On the system, the control aspect use the (Arduino UNO) digital controller with the motor drive circuit (L298N) as the nerve center controlled by the tracking system. In the same environment (sunlight, temperature, time) as the fixed solar panel in the experiment.The percentage record rate of the experimental record and conversion performance improvement is used to verify the possibility of achieving maximum power generation in a low-light environment due to the long power generation time during the day.

Keywords: Cadmium telluride (CdTs), Arduino digital controller,Tracking of Dual-Axle system

SPECIAL SESSION 3
人工智慧與智慧型計算之應用

#1002 PSO演算法中權重參數對數位系統系數估測之影響

王勁為、張偉德、邱昱榕

在本論文中，我們使用粒子群最佳化演算法(particle swarm optimization, PSO)來解決數位系統的係數估測問題。並且進一步測試和討論演算法中權重參數對估測表現的影響。為了驗證本方法在數位系統係數估測方面的可行性和有效性，本文以兩種不同的實驗作示範，包括：IIR數位系統及雙線性數位濾波器，同時針對模擬結果我們也做了一些陳述與說明。

關鍵詞：粒子群最佳化演算法，權重參數，雙線性濾波器，IIR數位系統。

In this paper, we will solve for the coefficient estimation problem of digital system using the particle swarm optimization (PSO) algorithm. The influence of the weight parameter of the algorithm on the estimation performance are further examined and discussed. To verify the feasibility and effectiveness of the proposed scheme on the coefficient estimation of digital systems, two different experiments including the IIR digital system and bilinear digital filter are demonstrated. Some conclusions are also addressed.

Keywords: Particle swarm optimization (PSO), Weight parameter, Bilinear filter, IIR digital system.

#1008 植基於區域紋理特徵之場景辨識

賴智錦、王鵬翔、邱顯峻

場景辨識在電腦視覺領域中具有多種應用。本論文提出一種新型態的區域紋理特徵用以擷取場景影像中的紋理資訊，再透過多層感知器模型進行分類模型的訓練及辨識。實驗結果顯示，我們所提的方法有不錯的效果。

關鍵詞：場景辨識、區域紋理特徵、多層感知器模型。

Scene recognition has diverse applications in the field of computer vision. In this paper, we propose a novel local texture features and then the scene classification is performed by using the multilayer perceptron. The experimental results show that the proposed approach is an effective method.

Keywords: Scene recognition, Local texture features, Multilayer perceptron.

#1015 經驗模態分解應用在母嬰心跳分離

施彥廷、沈靜茹、蔡湘俊、潘欣泰

本論文使用經驗模態分解法(Empirical Mode Decomposition, EMD)訊號分解孕婦腹部心電圖，透過分解出來的本質模態函式(Intrinsic Mode Function, IMF)，來完成孕婦胎兒心電圖分離技術。經驗模態分解法的目的是分離出以胎兒心電圖 (fatel ECG, fECG) 為主的本質模態函式，藉由將該函式重新合併而還原胎兒心電圖，達到孕婦胎兒心電圖分離的目標。本論文將以MIT-BIH母嬰心跳資料庫為實驗資料來源，由實驗結果可知本論文所提出之方法是有效果的。

關鍵詞：經驗模態分解法、心電圖、母嬰心跳分離。

This paper applies the Empirical Mode Decomposition (EMD) on decomposing the abdominal electrocardiogram (ECG) of pregnant women into several Intrinsic Mode Functions (IMFs) to fulfill the separation of fetal ECG from maternal ECG. The fetal ECG (fECG) is extracted by combing some IMFs obtained from EMD process. The MIT-BIH database is used for the experiment in this paper. The experimental results reveal that the proposed method performs well.

Keywords: Empirical Mode Decomposition, Electrocardiogram, Maternal ECG, Fetal ECG.

#1016 **卷積極限學習機於多角度人臉辨識之研究**

吳志宏、張簡嘉慶 、陳文盛 、王嘉均 、賴正齡

倒傳遞類神經網路為基礎的深度學習是目前 人工智慧與機器學習中，被廣泛應用的技術。然 而，類神經網路難以決定網路架構和漫長的訓練時 間，造成其實用時的障礙。本論文整合捲積特徵擷 取功能與極限學習機(Extreme Learning Machine)改 善傳統倒傳遞類神經網路的缺點，並實作於多視角 人臉影像。實驗結果顯示，我們的方法大幅減少人 臉辨識的訓練時間，同時保有相當好的辨識精確度。

關鍵詞：人臉辨識、極限學習機、卷積、池化、影 像特徵。

This study integrates Extreme Learning Machine (ELM) with convolutionary feature extraction for effective face image recognition. The experimental results show that our method improves the training performance of ELM for face recognition with satisfactory recognition accuracy.

Keywords ： Face Recognition, Extreme Learning Machine, Convolution, Pooling, Image Feature

#1045 **基於每人單張影像之人臉辨識**

歐陽振森、邱益鴻

本研究針對使用每人單張影像訓練人臉辨識模型之問題，提出一種結合3D臉部重建與特徵轉換之新方法。本方法利用direct volumetric CNN regression由每人之單張影像重建其對應之3D臉部模型，藉以擷取各種不同視角與雜訊程度組合之虛擬人臉影像。接著，使用facenet將每張人臉影像轉換成128維度之特徵向量。最後，以所取得之特徵向量集合訓練一個支持向量分類器，用其做為人臉辨識模型。實驗結果顯示，本方法對於包含14位註冊者的人臉辨識問題，正確率可達100%。

關鍵詞：人臉辨識、每人單張影像、3D臉部重建、特徵轉換、虛擬人臉影像、支持向量機。

#1050 **應用樹狀結構探勘模糊高效益項目集**

洪宗貝、林承郁、黃偉銘、李淑敏、林浚瑋

資料探勘為從資料庫中擷取出有用知識的重 要過程，目前廣泛應用在金融、科學等眾多領域上。在計算智慧研究上，模糊集合論因為其概念簡單且 類似於人類思考推理，長久以來一直被使用在許多 智慧型系統上。而近年來有一些模糊資料探勘演算 法結合上述兩門技術的優點而被設計出來，並在某 些領域上有好的效果。在本論文中，我們規劃研究 一個深具挑戰但具實用性的模糊探勘議題，稱為模 糊效益探勘，此議題同時考慮了項目的購買數量、 利潤及人類購買行為時容易了解的語詞意義。我們 設計樹狀結構的模糊高效益上界量測方法，能提供 向下封閉的特性，並且探勘出完整模糊高效益項目 集。透過實驗可得知，我們的方法相對的與先前的 方法減少執行時間。

關鍵詞：資料探勘、模糊集合、模糊效益探勘、樹 狀結構

SPECIAL SESSION 4
網路通訊與物聯網系統

#1007 時域交錯技術之GFDM收發機軟體無線電實現

高誌陽、陳偉榮

第五代行動通訊系統針對低延遲、高頻譜效益以及更大的傳輸頻寬進行系統設計，本研究基於軟體定義無線電平台USRP建立候選無線電技術-GFDM(generalized frequency division multiplexing)之收發機，並進行實際信號的發射與接收。為了進一步改善收發機之通訊品質，提出時域信號的實虛數交錯技術，藉由交錯技術使GFDM信號在傳輸過程中減少快速衰減通道所造成的連續錯誤。演算法驗證亦於軟體無線電平台進行，以觀察與測試本研究所提出之時域交錯技術所改善的實際信號性能。

關鍵詞：第五代行動通訊、廣義頻分複用技術、交錯技術、軟體無線電。

The fifth generation mobile communication system proposes low latency, high spectral efficiency and extreme data rate for new application and system design. Based on software define radio plat-form-USRP(universal software radio peripheral), time domain interleaving schemes of generalized frequency division multiplexing (GFDM) transceiver system is implemented to mitigate the performance degrading from frequency selective fading or fast fading, respectively. The experiment results are provided to show the benefits of the proposed algorithm and be compared with referred GFDM transceiver system.

Keywords: 5G, GFDM, interleaving, software define radio platform.

#1013 應用腦電波(EEG)與眼動波(EOG)於睡眠學習之研究

吳孟璇、洪仔慧、蕭凱文、孫啓華、姜義德

本論文藉由睡眠眼罩量測腦電波(EEG)，眼動波(EOG)，了解使用者睡眠的狀態，以藍牙結合手機App，各給予不同類型的音樂或教材，透過有效的睡眠輔助程式來執行的睡眠睡習的功能。經由腦電波及眼動波的量測，我們可以很明確的知道使用者的各個睡眠階段，以聯發科MT7697晶片為開發平台，在眼動期（作夢期），配合手機App導引，在夢中進行日間學習的整理及複習，可達到睡眠學習的效果。

關鍵詞：腦電波、眼動波、睡眠學習

This thesis intends to measure the Electroencephalography (EEG) and the Electrooculography (EOG) by eye mask to understand the state of sleep of the user, and combine the mobile phone App with Bluetooth to give different types of music or teaching materials through effective sleep aids. To perform the function of sleep, through the measurements of EEG and EOG, we can clearly know the user's various sleep stages. Using MediaTek 7697 chip as the development platform, in the Rapid Eye Movement (REM) with the App guide, the study and review of daytime learning can achieve the effect of sleep-learning.

Keywords: Electroencephalography (EEG), Electrooculography (EOG), Sleep-learning.

#1021 基於Hector SLAM和提議分佈之服務型機器人自主定位

江叔盈、蔣昊格、林思宇、游騰均

機器人的自主定位在機器人研究為特別重要的一環。這項工作的目標是在特徵相近的環境中解決機器人的定位問題。在這項研究中，使用具有360度雷達掃描儀整合Hector SLAM來構建環境地圖。然後，應用提議分布機率整合來自編碼器的定位機率和從雷射掃描到匹配的定位機率達成地位系統。實驗結果證明，該算法能夠在特徵相近或無特徵的環境中成功定位出機器人的位置。

關鍵詞：機器人定位、Hector SLAM、提議分布、雷射掃描儀

Self-localization of the robot plays an essential role in the robotics research. The goal of this work is to solve the localization problem of a robot in a featureless environment. In this research, the Hector SLAM with a 360-degree laser scanner is used to build environment map. Then, the proposal distribution probability is applied to integrate the probability of localization from the encoder and the probability of localization from scan-to-match with a laser scanner. The experiment result shows that the proposed algorithm can successfully localize the position of the robot in a featureless environment.

Keywords: Robot positioning, Hector SLAM, Proposal distribution, Laser scanner.

Special Session 5
物聯網應用

#1019 **物聯網於磁通閘感測器應用：開發與設計**

徐昌鴻、張嘉文、劉瑞榮、鄭善仁

智慧屋設計開發設計已趨向成熟階段。對於家庭電磁裝置包含電感性元件「靜止電機變壓器」以及「旋轉電機動力馬達」等，其電感性特性電磁訊號偵測顯的相當重要。可利用來檢測設備運轉狀態。本研究提出一種非晶質合金所製成磁通閘感測器（Fluxgate Sensor），初始建立鐵心模型以有限元素分析法(Finite element analysis, FEA)進行磁通變化，再將其實際安裝於500Hz~3,000 Hz頻率範圍。研究結果分析感測器對電力訊號抵抗諧波能力與其結構磁通分佈有關，並安裝聯發科物聯網晶片Linkit-Smart 7688-Duo雙核心結合此裝置進行智慧屋監測。

關鍵詞：物聯網、聯發科Linkit-7688-Duo晶片、通量閘感測器、敏感度

Smart house in design and development has become more and more grow up recent year. There include two important component use to detect induction performance and magnetic flux which having static electric power transformer and rotating electric motor, respectively. It can be used to detect operation state of the electrical equipment. This study presents an amorphous alloy which is to fabricate a fluxgate sensor. First, the magnetic core model in initial state of magnetic flux distribution results to build simulation, finite element analysis (FEA) is developed. Then, this device with MediaTek LinkIt™ Smart 7688 duo MT7688 microchip to connect cloud system in remote and control for smart house is addressed.

Keywords：Please do not exceed six words.

#1020 **物聯網監測電力裝置運轉殘餘生命預測機制**

徐昌鴻、張嘉文、劉瑞榮、鄭善仁

本研究主要提出以物聯網(Internet of Things, IoTs)為結構基礎裝置安裝在電力裝置上，它可以進行一種系統運轉狀態的測量與數據存儲的過程進行裝置殘餘壽命預測(Remaining life prediction)。而該方法將用於電力變壓器的狀態遠程監測(State remote)。測量數據多來自變壓器週邊感測器用來截取並存儲在遠端伺服器數據庫中，用於預測電力變壓器的壽命。再者，利用韋伯(Weibull)分佈定理應用於運轉中的電力裝置物理參數數據來分析。本研究介紹了一個狀態遠程監測系統，並深入分析了數據儲存子系統。最後，介紹此裝置安裝和維護重要因素，著以商業角度預測電力裝置的殘餘壽命。

關鍵詞：物聯網、智慧變壓器、生命預測

The main objective of this paper is the design and development of the data storage and analysis method of a measurement system that will be used for condition remote monitoring (CRM) of power transformers. The measured-data is captured from multi-sensors and stored in the server equipment database will be used for the prediction of the power transformer of life. These data analysis of on-line transformer physic parameter has been developed using the theorem of Weibull distribution. This paper is introduced a completed CRM system and describes deeply to analyze the data-store subsystems. Finally, the fundamental considerations about the installation and maintenance are introduced. Next, the results of the project are described, and the transformer life for prediction method with commercial CRM systems is discussed. The CRM system is currently successfully installed in power transformers.

Keywords：IoTs, remote device, life prediction

#1032 移動式機器手臂協同運控制系統研製

羅振中、尤竣賢、陳定邦、張家瑋、張嘉文

本論文主旨是利用多臺機械手臂車以機器人 合作控制的技術，結合影像辨識的視覺系統，達到判斷不同種類的目標物並協同搬運至指定區域之 功能，嘗試實際應用在救災、教育等目的。本論文研究設計一臺機械手臂車，搭載專業攝影鏡頭，完 成平穩且具移動功能的車體架構。將各系統程式語 法整合於 Python-GUI 設計之人機介面，在特定環境 下，假如手臂車無法獨立夾取，則呼叫第二臺機械 手臂車協同搬運至指定區域。

關鍵詞：機械手臂車、群組合作控制、影像處理系統(OpenCV)、機器人運動學。

In this paper, two raspberry pi based mobile manipulators are considered to perform the cooperative tasks. A camera is utilized to capture the distance and position of the target. From experimental results, it can be seen when the size of object is too large such that one mobile manipulator cannot carry the object by oneself, another mobile manipulator would be demanded to assist.

Keywords: Cooperative control, OpenCV

SPECIAL SESSION 6
智慧型系統

#1003 應用深度學習於資訊安全風險評鑑

張力允、李仁鐘

日新月異的科技進步，直接影響了人們在資訊 上之使用，在這樣的環境下，組織應如何保護資訊 使用中的安全，一直都是非常重要的議題，資訊安 全最主要保護之三元素是：機密性(Confidentiality)、 完整性(Integrity)及可用性(Availability)。 資訊安全管理上，風險評鑑是非常關鍵的一項 活動，現今的風險評鑑活動大多是以人工方式進行， 評估過程可能會較主觀，本論文將使用決策樹、支 援向量機、線性迴歸及深度學習進行資料分析，將 人工評估出來之結果進行資料整理後，利用上述四 種方法進行資料分析，並將這四種資料分析所得到 之結果進行比較，實驗結果得知，深度學習可以得 到最佳正確率，因此，本論文提出應用深度學習於 進行資訊安全風險評鑑。

關鍵詞：資訊安全、風險評鑑、決策樹、支援向量 機、線性迴歸、深度學習

The rapid advancement of science and technology has directly affected people's use of information. Under such circumstances, how organizations should protect the security of information has always been a very important issue. The three main elements of information security are: Confidentiality, Integrity and Availability. In information security management and risk assessment is a very critical activity. Most of the current risk assessment activities are conducted manually. The assessment process may be comparatively subjective. This dissertation will use decision tree, support vector machine, linear regression, and deep learning to conduct data analysis, and then manually review the results of the assessment. Using the above four methods for data analysis, experimental results deep learning gets the optimal accuracy. This dissertation proposes applying deep learning to the information security risk assessment.

Keywords：Information Security, Risk Assessment, Decision Tree, Support Vector Machine, Linear Regression, Deep Learning

#1034 應用模糊推論於線上學習專注度評分之視線追蹤系統

高子祺、林志瓏、林鈺琴、孫宗瀛

隨著科技的發展，網路與個人電腦普及程度提 高，線上學習亦隨之成為趨勢，然而長時間專注於 課程學習實屬難事。因此，利用學習者的視線專注 區塊以了解學習狀況，已成為相當熱門的議題。本 研究提出以視線追蹤為基礎的學習者專注評分系 統，利用3D 攝影機擷取頭部姿態，進行眼睛追蹤、 瞳孔位置偵測，並以模糊推論推斷學習者的視線區 塊，與學習視窗比對，執行學習專注度評分。

關鍵詞：視線偵測、眼部追蹤、瞳孔輪廓、模糊系統。

#1055 Intelligent Data Collection with Smart Sensor

Jhih-Wei Wu and Jin-Tsong Jeng

In recent years, cloud service is a trend of modern information technology. Cloud service let users get the services they need, when and where they need them. The only requirement is to connect to the network. In this paper, we proposed an intelligent data collection system to monitor temperature and humidity. That is, we use STM32F103C8T6 blue pill Arduino board to control sensor to collect environment data and upload data to cloud service platform by using ESP-8266 WiFi model. The database is stored at the cloud, it is not necessary to store all the data in the hardware device. We also can change different kind of sensor to collect different data under smart sensor. The results show data which we collect can be checked from website or download it to do data analysis.

Keywords：Cloud service, intelligent data collection system, smart sensor

#1056 **Solving Honeymoon Bridge Based on MLP and Ant Algorithm**

Cheng-Shao Cheng and Jin-Tsong Jeng

Recently, machine learning had become a major study of information science. In 2016, Alpha Go had defected Lee Sedol. That is, machine learning is almost unstoppable in perfect information games. On the other way, deep Q learning is also usually seen at game agent with playing Atari games. In this paper, we try to build an agent based on multi-layer perceptron (MLP) deep neural networks and ant algorithm to play honeymoon bridge, which is a non-perfect information game by above methods and compare their efficiency.

Keywords：Honeymoon bridge, Q learning, multi-layer perceptron (MLP) deep neural networks, ant algorithm

SPECIAL SESSION 7
智慧型機器人系統

#1024 模糊導引法則運用於車型倒單擺循跡控制
陳柏瑞、許駿飛、李祖添

本論文提出了一串聯式平衡移動控制器於車型倒單擺系統上，針對前置控制設計方式是利用LQR控制理論在平衡點周圍線性化進行設計，另外針對後置控制設計方式是利用PID控制理論來改善系統響應結果。接著，本論文提出了一模糊導引控制法則，讓車型倒單擺系統可以利用一顆光感測器來感測地上的黑線，並可以完成追蹤黑線的任務。

關鍵詞：倒單擺系統、PID控制器、串聯式架構、模糊導引控制、追蹤黑線。

#1025 慣性倒立擺平衡控制之雙階層式模糊控制設計
陳柏瑞、許駿飛、李祖添

本論文提出了一種新的雙階層式模糊控制方法於慣性倒立擺直立平衡控制問題上，第一層控制器使用邏輯控制器結合線性化方法來控制倒立擺的第一優先級參數。然後，第二層控制器控制第一層控制器以引導倒立擺到達設定點。最後，通過實際實驗結果說明所提出之雙階層式模糊控制系統對慣性倒立擺系統具有良好的控制響應。

關鍵詞：慣性輪倒立擺、階層式架構、模糊控制、線性化回授控制。

#1026 動態球型機器人之模糊平衡控制系統設計
高瑋甫、許駿飛、李祖添、李柏坤

本論文首先製做了一台動態球型機器人，整台機構與地面只有一個接觸點，這使得整個機器人系統處於一個動態不穩定的狀況。接著，為了達到機器人系統穩定移動，需要有一個精密的控制器來控制，為了設計控制器及系統特性分析，本論文使用了並聯式架構作為控制器之設計方法，透過模糊位置控制器並聯一個PD角度控制器，來達成最後的平衡移動控制量。

關鍵詞：動態球型機器人、平衡控制、模糊系統。

#1027 利用模糊系統設計兩輪平衡機器人之重心補償器
高瑋甫、許駿飛、李祖添

本論文基於模糊系統設計提出了一個重心補償器。為了驗證所設計平衡控制器及重心補償器之效能，本論文規劃了一個任務場景實驗，當機械手臂做一些動作姿態改變的時候，觀察重心補償器的效果，經由實測結果驗證所設計的控制系統及重心補償器均可以獲得良好的效果，而且重心補償器成功地克服機械手臂姿態改變之所造成的機器人重心影響。

關鍵詞：兩輪平衡機器人、平衡控制、機械雙臂、模糊系統、重心補償。

#1059 智慧型工廠之製造與即時品質檢測系統之設計

林群富、周世傑

近年來所提出的智慧工廠的概念，與傳統的工 廠自動化的概念最大的差異點，在於物聯網概念與 相關技術的引進。引進物聯網概念的智慧工廠，其 目標就是利用物聯網相關技術對工廠中的自動化 製造設備 以及自動化缺陷檢測設備進行智慧管 理，達到顯著提高生產效率與品質的目標。智慧工廠所須之設備大致可分成製造設備、功能測試設 備、缺陷檢測設備三大類。缺陷檢測設備，主要是在整個產品的製造以及封裝與功能測試的過程 中，設下檢查哨，階段性地檢測半成品，找出具有 缺陷的不良品並將之挑選出。於是該不良品不再進 行接下來的所有流程，因而減少了成本，也提高了最終產品出貨時的良率。在分類演算法的發展上， 近年來深度學習演算法取得了重大的突破。因此近 幾年很多研究嘗試將深度學習演算法應用於各種 領域。然而，目前的研究較多著墨於深度學習演算 法於其應用的學習效能討論。而較少研究著墨於， 使用到深度學習演算法的系統，系統運作時的環境 設計。例如，系統運作時的網路架構等等。因此， 本論文首先規劃一種有使用到深度學習演算法的缺陷檢測系統的智慧工廠。針對該種類型的智慧工 廠，設計專屬的環境架構。

關鍵詞：智慧工廠、缺陷檢測。

The most obvious difference between the recent smart factory and the traditional automation factory is that the techniques about internet of thing (IoT) are introduced. The smart factory that employs IoT techniques intelligently manages the automated manufacturing equipment and automated defect detection equipment to improve production efficiency and quality significantly. The equipments used in the smart factory are manufacturing equipments, functional testing equipment and defect detection equipment. As a result, the defective product no longer goes through all of the following processes, thus reducing costs and improving the yield of the final product shipped. In the development of classification algorithm, a huge breakthrough has been made in the deep learning algorithm in recent years. Therefore, in recent years, many studies have tried to apply deep learning algorithm to various fields. However, most of the current studies focus on the performance of the deep learning algorithm in their applications. Fewer studies research the environmental design for the system employing deep learning algorithm. Therefore, this study presents a architecture of smart factory which employing deep learning algorithm in defect detection system. Thereafter, this study presents the network architecture for the proposed smart factory. Finally, the internet technology for defect detection system with deep learning method in smart factory is presented.

Keywords：Smart factory, defect detection.

Special Session 8
資料驅動計算智慧技術與應用

#1009 強化型烏鴉搜索演算法求解隨機模擬最佳化問題

洪士程、楊宗燁

本篇論文針對飯店訂房限制收益最佳化問 題，提出一個強化型烏鴉搜索演算法(Enhanced crow search algorithm，ECSA)，其目的是要在有限 的計算時間內找出一組最佳配置解，使得飯店訂房 問題獲得最大利潤。強化型烏鴉搜索演算法，主要 核心參數為感知機率(AP)與飛行長度(FL)，以此為烏鴉個體進行新可行解之搜尋與組合。接著將所提 出的強化型烏鴉搜索演算法，套用在飯店訂房限制 收益最佳化問題以測試效能。飯店訂房限制收益最 佳化問題是屬於困難的隨機模擬最佳化問題，具有 很大的解空間。最後，將所提出的演算法與粒子群 演算法(PSO)、人工蜂群演算法(ABC)以及原始的烏 鴉搜索演算法(CSA)等三種演算法進行比較。由測 試結果顯示所提出的強化型烏鴉搜索演算法，不論 在解的品質和計算效率上，都能獲得很好的效果。

關鍵詞：烏鴉搜索演算法、感知機率、飛行長度、 飯店訂房配置問題。

In this paper, an enhanced crow search algorithm, abbreviated as ECSA, is proposed to solve the hotel booking limits problem. The goal is to search for a good enough solution with the objective of maximizing the expected revenue using limited computation time. The control parameters of the ECSA contain the awareness probability (AP) and flight length (FL). These two control parameters are varied to speed up the search for the optimal solution when the number of iterations are increased. The proposed ECSA is applied to a hotel booking limits problem. Finally, the proposed ECSA is compared with the particle swarm optimization (PSO), artificial bee colony (ABC), and original crow search algorithm (CSA). The solution of good enough booking limits obtained by the proposed ECSA is promising in the aspects of solution quality and computational efficiency.

Keywords ： Crow search algorithm, awareness probability, flight length, hotel booking limits problem.

#1022 使用深層卷積神經網路辨識軟性印刷電路板之線路瑕疵影像

郭時寧、莊家峰、倪偉恩

為改善傳統的軟性電路板線路檢測方式，本論 文引入深度學習架構，並使用深度卷積神經網路，試圖提高檢測準確度。目前實驗是利用由軟性電路 板影像線路以人工切割好的小塊樣本影像，收集訓 練用的正常與瑕疵樣板各100張，測試之正負樣板 各100張。以 Alexnet 採用由無到有的直接訓練，測 試辨識率為91%。以 Alexnet 採用遷移學習的方式 進行訓練，則測試辨識率為100%。結果顯示此法在 自動瑕疵檢測的可行性。

關鍵詞：自動光學檢測、深度學習、線路瑕疵檢測、深度卷積神經網路。

This paper introduces a deep learning structure into traditional methods for inspection of line defects on flexible printed circuits. A deep convolutional neural network is employed to improve inspection accuracy. The current experiment collects 100 manually cut patches of normal and defect line images for training. Another 100 patches of normal and defect line images are collected for test. The test accuracies are 91% and 100% when using the Alexnet with and without transfer learning, respectively. The promising result shows the feasibility of automatic line defect detection using deep learning.

Keywords: AOI, deep learning, line defect detection, deep convolutional neural network.

#1036 **語音助理於工具機控制之應用**

林正堅、林學儀、林隆邦

隨著科技日益進步，人工智慧(Artificial Intelligence, AI)已成為專家系統的熱門話題，而自 動語音辨識系統已成為人類在生活中廣泛地運用 於各個角落中，科技技術快速的發展對人類社會有 著極大的影響。儘管語音辨識技術在這幾年來突飛 猛進，仍然有許多方面尚待突破。因此本論文提出 一種使用者透過語音助理(Voice Assistant)系統下達 指令控制工具機(Machine Tool)的方法，通過將語音 訊號轉換為文字資訊並輸出本文。為了讓機器能夠 理解使用者所下達之命令，我們使用自然語言處理 來達成語義分析。將所建置的語料庫進行斷詞 (Segmentation words)，並提取出重要的關鍵字作為 操作工具機的指令。提取出的關鍵字需要轉換成機 械碼與機器做對應並執行相關指令運作。在實驗結 果中顯示了所提出的兩個方法優於其它方法。

關鍵詞：語音控制、自然語言處理、人工智慧、語 音識別。

#1037 **增強式學習於深度神經網路之仿人類遊戲控制策略應用**

林正堅、游正義、黃祿勳

本論文提出一種使用遊戲畫面作為輸入的遊 戲控制方法，改進卷積神經網路的架構，使用主成分分析初始化卷積核的參數，透過多層疊加這些卷 積核，並利用增強式學習的方式讓演化法自我學習 畫面的特徵與基於這些特徵的遊戲控制策略，有效 的實現模仿人類利用視覺作為輸入的遊戲控制方 法。此架構命名為增強式 Q 學習之深度神經網路 (Reinforcement Q-Learning base Deep Neural Network, RQDNN)，在本論文的實驗中 RQDNN 的 效果優於人類玩家以及其他深度增強式學習演算法，另外在訓練所需的計算資源上 RQDNN 也遠少 於其他使用卷積神經網路的深度增強式學習演算法。

關鍵詞：主成分分析、增強式學習、Q 學習、 深度增強式學習

Special Session 9
機器人與機器視覺之應用

#1030 **心跳感測器輔助影像深度學習應用於臉部痛苦指數之判別**
陳梓瑄、林高遠、陳美勇

論文以人類臉部影像為輸入資料，用類神經網 路即時測得受測者疼痛水準的方法，並以心跳數作為 輔助，兩者相搭達到最佳的痛苦識別。本論文將臉部 影像做最大池化(Max Pooling)處理後，輸入類神經網 路做回歸訓練與測試。可以達到較小的均方誤差 (MSE=0.17)與較接近1的皮爾森相關係數(r=0.94)。速 率表現方面，本論文以C#實作出的程式在i5雙核心的 電腦上可以達平均24 FPS。偵測心跳部分以Arduino 微處理機搭配偵測心跳的IC，將資料傳輸到電腦上。

關鍵詞：監督式機器學習、特徵學習、痛苦偵測、電 腦視覺、Arduino

#1031 **運用影像增強技術於高分子分散液晶之透明顯示器**
梁庭綱、蘇峻緯、陳美勇

本研究為專注於影像增強技術運用於高分子分 散 液 晶 透 明 顯 示 器 中 （ Polymer-Dispersed Liquid Crystal (PDLC)）上的影像處理，其為一種製造透明顯 示器的材料，而 PDLC 具有高透明度、低電壓驅動， 易於製造等特點，可作為便攜式顯示器使用。於透明 顯示可見的實際影像由輸出影像與背景光等等組成， 與原始影像相比有一些缺點，譬如色彩不飽和、低分 辨率。簡單影像可以直接增強對比度調整，但複雜的 影像常常經調整後會失真和異常，而為了克服這些問 題，我們採用影像的霧化模型模擬透明顯示器，暗通 道先驗來銳化影像並結合引導濾波來優化暗通道先 驗估計的參數，但是這些過程將導致灰階值下降，將 會降低部份影像低灰階部份的分辨率，所以我們提出 能將目標直方圖區域獨立運算的方法來解決問題。保 持其他更較高灰階區域的影像不變，最後可以得到銳 化的影像，而其可以適應透明顯示的干擾，達成增強 影像的色彩飽和度、分辨率，甚至顯示器的透明度都 有所改善，使得於透明顯示器所見的實際影像更接近 原始影像，更加清晰明瞭。

#1041 **Inertial Measurement Unit (IMU) sensors for robotic applications:A survey**
Yu-Sheng Lu and Peter Berkelman

針對市面上可購得的慣性測量單元（IMU）感測器， 本文提供了最新的回顧。更具體地說，本文描述了 一些適合機器人應用的 IMU 感測器。

關鍵詞：慣性測量單元，機器人應用

This paper provides an up-to-date review on commercially available Inertial Measurement Unit (IMU) sensors. More specifically, the paper describes those IMU sensors that are appropriate for robotic applications.

Keywords ： Inertial Measurement Unit, robotic applications.

#1049 並聯式機器人之反覆式學習控制

陳俊達、鍾浩仁、劉兆軒、徐士恆

完整建立電液伺服驅動並聯式機器人之動態 方程式，並設計一強健且具自我學習之智慧型控制器，使機器人能達到精密定位及準確軌跡追隨，有 其必要性。本文中使用 PID 型反覆式學習控制器以 及順滑模態反覆式學習控制器，實現電液伺服驅動 並聯式機器人之定位控制及動態軌跡追隨模擬。研究結果顯示順滑模態反覆式學習控制器在 機器人控制定位及運動軌跡學習速率上，優於 PID 型反覆式學習控制器，且順滑模態反覆式學習控制 器具有良好系統強健性。

關鍵詞：電液伺服驅動並聯式機器人、順滑模態、 反覆式學習控制。

It is required to develop the dynamic models of the electro-hydraulic servo parallel kinematic robot. In this paper, the PID iterative learning controller and the sliding-mode iterative learning controller are utilized to control the position and the trajectory tracking of the parallel kinematic robot. The simulation results show that the sliding-mode iterative learning controller is superior to PID iterative learning controller, especially in the reference position tracking and learning speed. Sliding-mode iterative learning controller not only can provide good positioning and iterative tracking abilities, but also is able to obtain the good robustness.

Keywords：Electrohydraulic Servo Parallel kinematic robot , Sliding-mode , Iterative learning control

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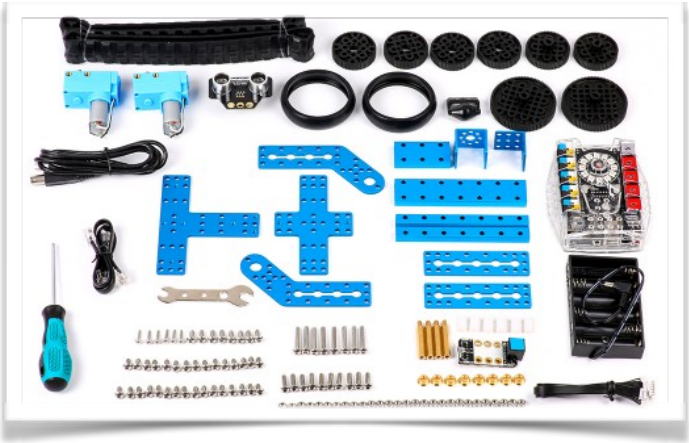

影像視覺

深度學習

機器人運動控制

樹莓派3

AR手勢辨識

產品規格：

1.具備編碼器PWM輸出馬達2組
2.創意發想金屬框架1套
3.Mega2560嵌入式控制器
4.HD720P高品質攝影鏡頭
5.1.2G四核心高速處理器
6.WI-FI無線網路模組
7.語音辨識控制模組
8.AR手勢辨識
9.超音波感測器
10.循跡感測器
11.影像處理應用程式
12.提供開源深度學習軟體
13.支援Android與IOS APP
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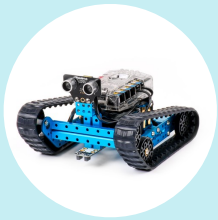
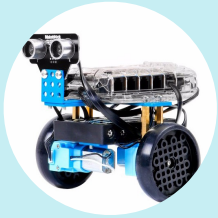
15.提供感測器擴充埠
16.鋰電池模組一組
17.作業系統安裝設定
18.產品教育訓練光碟一片
19.範例程式
20.收納整理盒一組

符合108課綱





1

機器人控制

馬達控制

感測器應用

2

視覺辨識

顏色辨識

物體追蹤

3

人工智慧

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