FCNDT 2024

1st Formosa Conference on Non-Destructive Testing

International Convention Center Tainan (ICC Tainan)

4-5 October 2024

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The Society for Nondestructive Testing & Certification of Taiwan (SNTCT)

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1st Formosa Conference on Non-Destructive Testing
(FCNDT 2024)

Welcome Address from Conference Chair

Dear Friends and Colleagues of NDT:

It is our great honor to invite you to the 1st Formosa Conference on Non-Destructive Testing (FCNDT 2024), organized in conjunction with the biannual meeting of the Society for Nondestructive Testing & Certification of Taiwan (SNTCT). The conference will take place at the International Convention Center in Tainan on October 3-4, 2024.

The Organizing Committee has developed a comprehensive technical program designed to be highly informative for all attendees. This includes five plenary speeches covering a broad range of topics, from progress of ISO 9712:2021 certification in Asia-Pacific region, advanced NDT technologies to Industry 4.1, 4.2, and digital twin innovations. Moreover, four expert forums will focus on key areas, including offshore wind turbine maintenance and in-service inspection, national standard maintenance and ISO 9712 certification in Taiwan, advanced NDT technologies for steel bridge applications, and the use of UAVs in NDT. A wide selection of practical and academic articles will also be shared by professional colleagues, offering valuable insights and expertise in NDT. We are confident that FCNDT will evolve into a globally significant conference in the field of NDT.

The SNTCT has been established since 1978. We sincerely appreciate the valuable guidance and ongoing support from our friends and colleagues, which has been instrumental in advancing the NDT personnel qualification and certification system in Taiwan, transitioning from employer-based certification to alignment with international ISO 9712 standards represents a significant milestone in our efforts. Since 2021, we have proudly been a member of the ICNDT Multilateral Recognition Agreement (MRA) Schedule 2, which further strengthens our commitment to maintaining the highest standards in NDT personnel qualification and certification.

I would also like to extend a warm welcome to Dr. SK Babu, Chairman of the International Committee on NDT, as well as Dr. Takamasa Ogata and Dr. Norikazu Ooka, the President and Former President of the Asia-Pacific Federation for NDT (APFNDT), who will be joining us at the conference. Their presence will greatly enrich the event, and we eagerly look forward to seeing you at FCNDT 2024 in Tainan.

Sincerely,

Ching-Chung Yin
President
The Society for Nondestructive Testing & Certification of Taiwan (SNTCT)

Committee

Conference Chair: Ching-Chung Yin (National Yang Ming Chiao Tung University, TW)

Conference Co-Chair: Shyh-Hau Wang (National Cheng Kung University, TW)

Advisory Board Chair: Chih-Hung Chiang (Chaoyang University of Technology, TW)

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Che-Hwa Yang (National Taipei University of Technology, TW)
Reza Zoughi (Iowa State University, USA)
Takahide Sakagami (Kobe University, JP)

Organizing Committee: Ju-Yi Lee, Po Ting Lin, Yung-Shun Su

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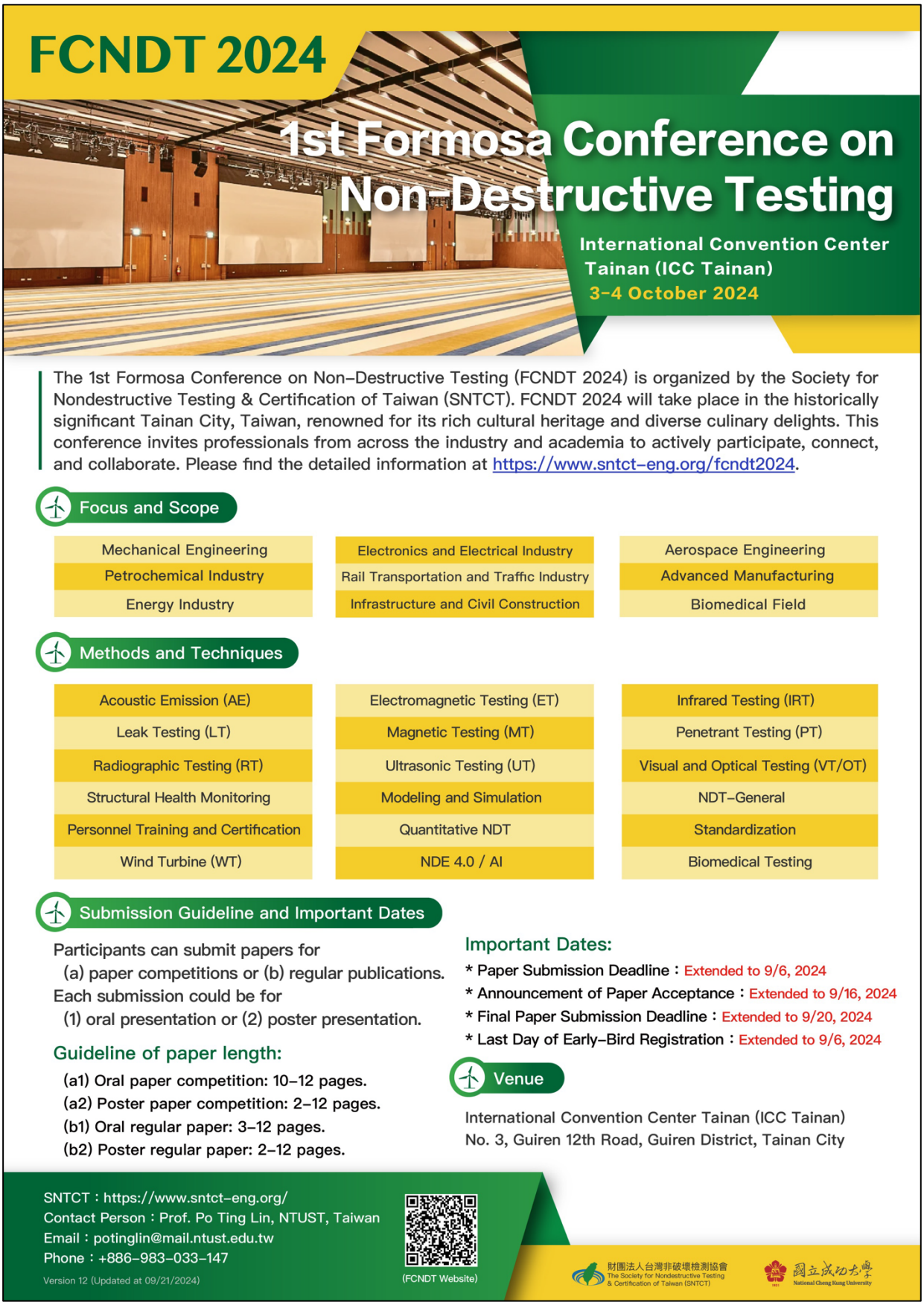
Organizers: The Society for Nondestructive Testing & Certification of Taiwan (SNTCT), National Cheng Kung University (NCKU)

Co-Organizers: National Central University (NCU), National Taiwan University of Science and Technology (NTUST), Intelligent Manufacturing Research Center of NCKU

Call for Papers



Conference Venue

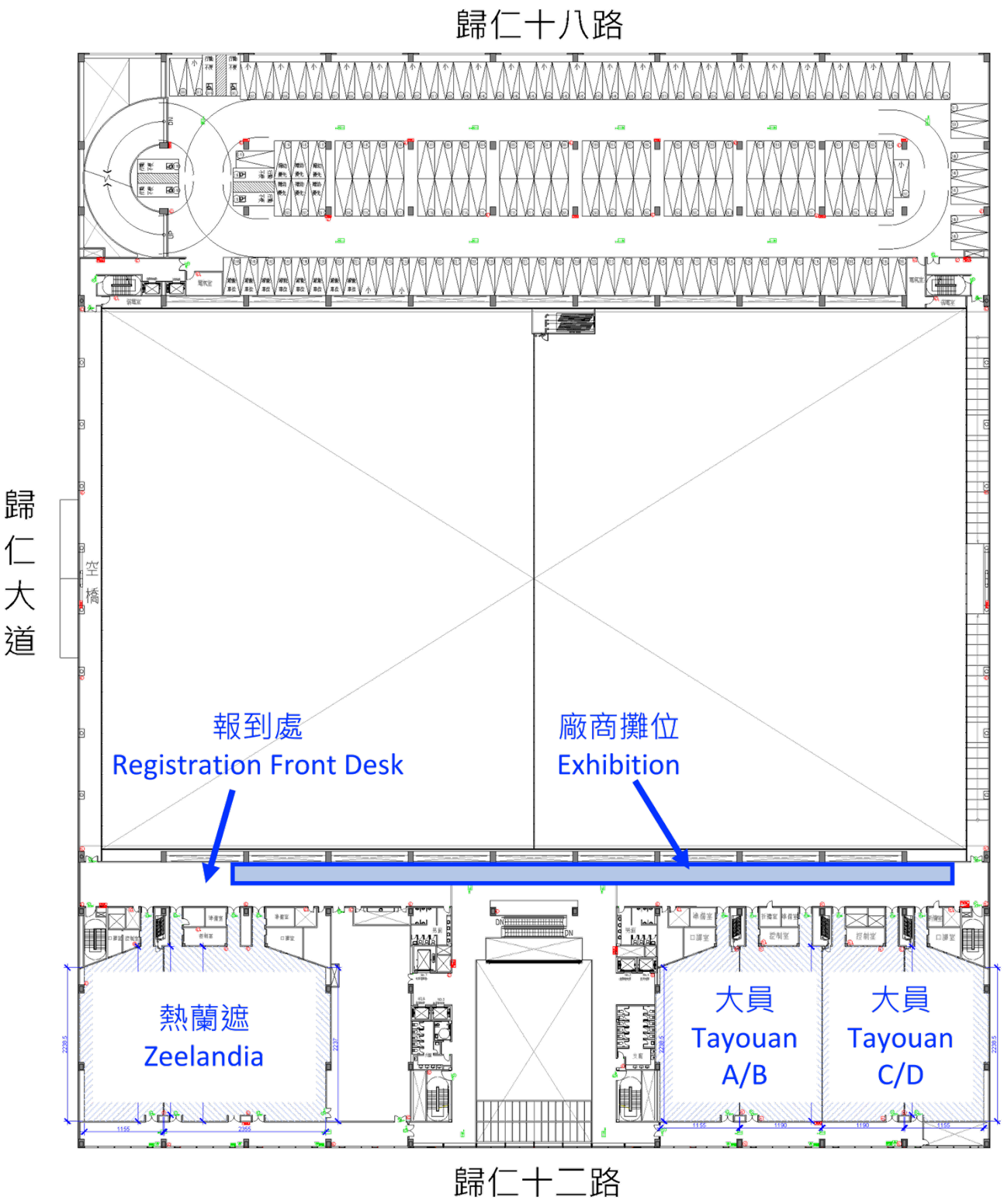
Conference Venue: International Convention Center Tainan (ICC Tainan)

Registration Front Desk: Hall way outside of Room Zeelandia of ICC Tainan (3rd Floor)

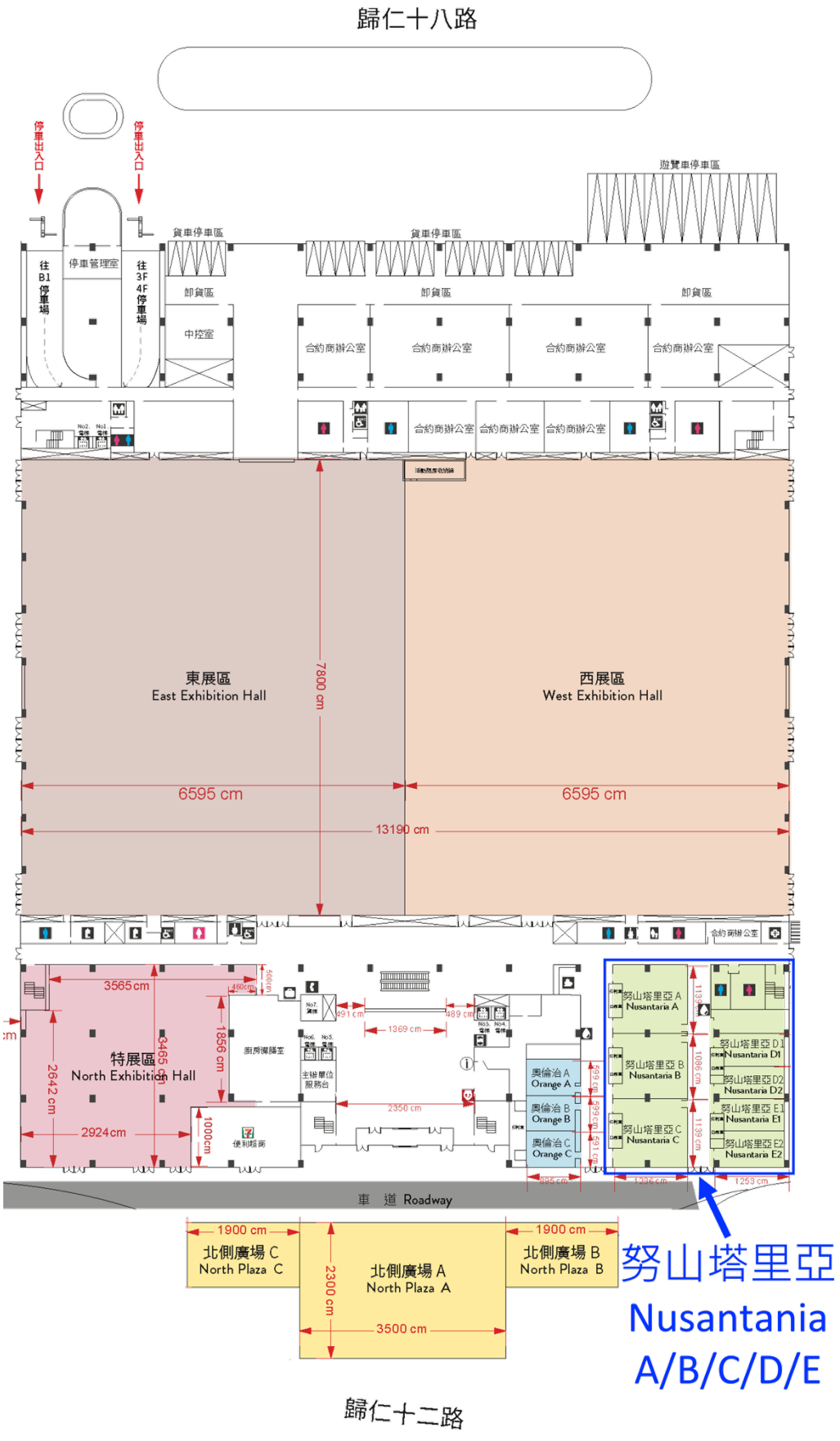
Banquet Location: Room Zeelandia of ICC Tainan (3rd Floor)

Address: 3 Guiren 12th Road, Guiren District, Tainan 711, Taiwan

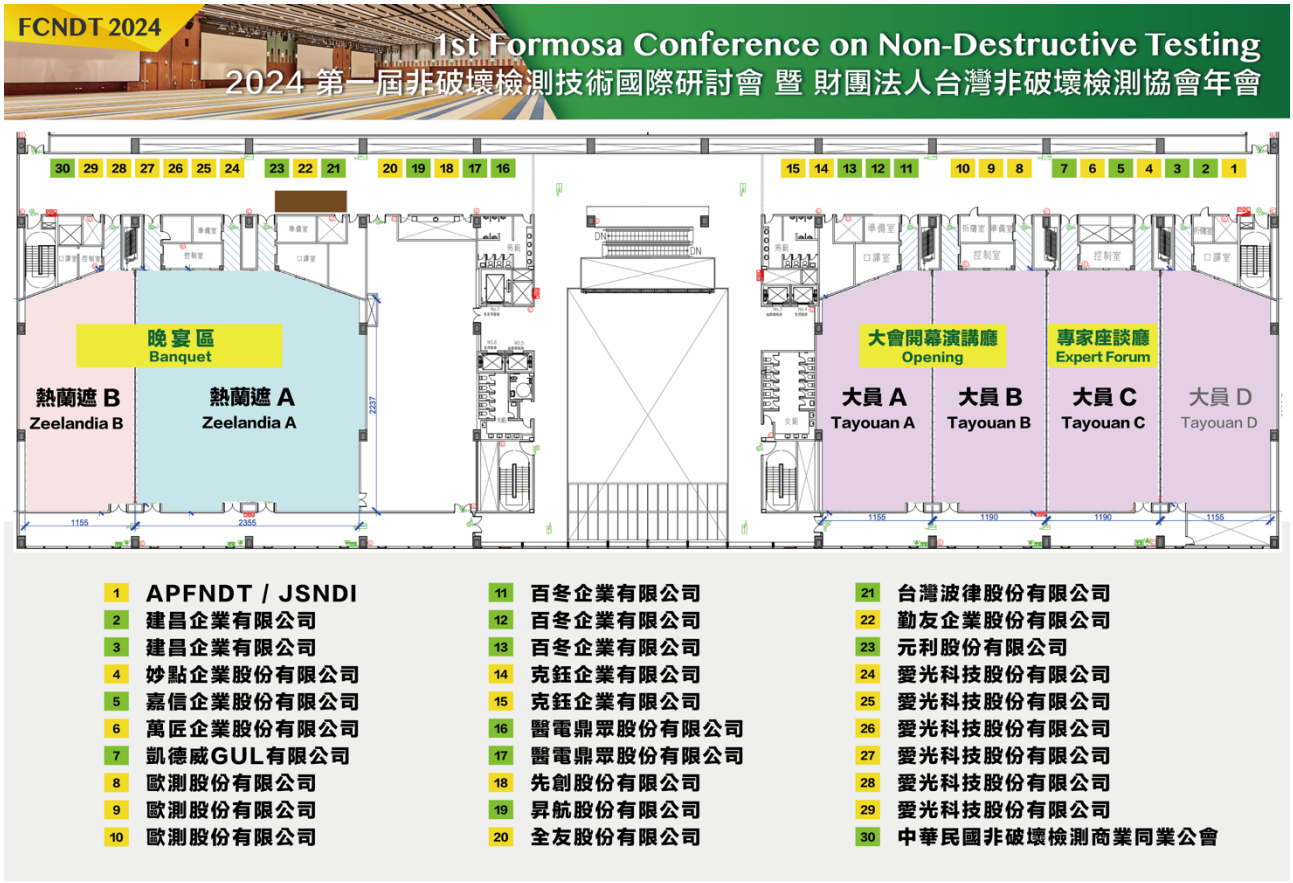
Map of ICC 3rd Floor



Map of ICC 1st Floor



Map of Exhibition (3rd Floor)



1	APFNDT / JSNDI	11	百冬企業有限公司	21	台灣波律股份有限公司
2	建昌企業有限公司	12	百冬企業有限公司	22	勤友企業股份有限公司
3	建昌企業有限公司	13	百冬企業有限公司	23	元利股份有限公司
4	妙點企業股份有限公司	14	克鈺企業有限公司	24	愛光科技股份有限公司
5	嘉信企業股份有限公司	15	克鈺企業有限公司	25	愛光科技股份有限公司
6	萬匠企業股份有限公司	16	醫電鼎眾股份有限公司	26	愛光科技股份有限公司
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9	歐測股份有限公司	19	昇航股份有限公司	29	愛光科技股份有限公司
10	歐測股份有限公司	20	全友股份有限公司	30	中華民國非破壞檢測商業同業公會

Program at a Glance

2024/10/4 (Fri) (NEW)

	Room: TAYOUAN A/B 3F	Room: NUSANTARIA C 1F
8:30~9:30	Registration 3F (NEW)	
9:30~9:50	**Opening** (NEW)	
9:50~10:30	**PS1: Plenary Speech 1** (NEW) Chair: Ju-Yi Lee Title: Progress & Development of ISO9712:2021 Certification in the Asia-Pacific Region Speaker: Sajeesh Kumar Babu	
10:30~10:50	Coffee Break	
10:50~11:30	**PS2: Plenary Speech 2** Chair: Ching-Chung Yin Title: Microwave Real-Time and High-Resolution Imaging System Development for NDT Applications Speaker: Reza Zoughi	APFNDT AEC Meeting (NEW)
11:30~12:10	**PS3: Plenary Speech 3** (NEW) Chair: Shyh-Hau Wang Title: Digital Twin - Enabling Technology for Future Aircraft Health Monitoring Speaker: Fuh-Gwo Yuan	
12:10~13:30	Lunch Time	APFNDT / SNTCT Lunch Meeting (NEW)

	Room: TAYOUAN C 3F	Room: NUSANTARIA A 1F	Room: NUSANTARIA B 1F	Room: NUSANTARIA D 1F	Room: NUSANTARIA E 1F
	EF1: Expert Forum 1 (Chinese) Chair: Pao-Hong Tong	**SS3: Optical Metrology** Chair: Ju-Yi Lee	**SS7: Civil NDT** (NEW) Chair: Chia-Chi Cheng	**NDT-E: NDT-General (English)** (NEW) Chair: Ching-Chi Chen, Po Ting Lin	**EOC: English Oral Competition** (NEW) Judge: Jiunn-Woei Liaw, Jia-Hong Sun, Juin-Fu Chai
13:30~13:48	Title: Offshore Wind Turbine Maintenance and In-Service Inspection Development Speaker: Pao-Hong Tong, Ren-Rong Chang, Wei-Te Chen, Ryan Chang	1017	Keynote: Revolutionizing Infrastructure Management with NDT Speaker: Tomoki Shiotani	1013	1018
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14:06~14:24		1027	1039	1019	1035
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14:42~15:00		1044	1055		1081
15:00~15:20	Coffee Break				
	Room: TAYOUAN C 3F	**Room: NUSANTARIA A 1F**	**Room: NUSANTARIA B 1F**	**Room: NUSANTARIA D 1F**	**Room: NUSANTARIA E 1F**
	EF2: Expert Forum 2 (Chinese) Chair: Yung-Shun Su	**SS1: Infrared Thermography** Chair: Chih-Hung Chiang	**SS6: AI** Chair: Che-Hwa Yang	**SS2: Smart Materials for Sensing and Related Applications / SS5: Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves** (NEW) Chair: Po Ting Lin	**COC: Chinese Oral Competition** (NEW) Judge: Jiunn-Woei Liaw, Jia-Hong Sun, Juin-Fu Chai
15:20~15:38	Title: CNS National Standard Maintenance and Taiwan ISO 9712 Certification Speaker: Yung-Shun Su, Pao-Hong Tong, Kent Cheng	Keynote: Development of NDT & E Techniques for Long-Span Steel Bridges Based on Multi-Wavelength Infrared Measurements Speaker: Takahide Sakagami	1041	Keynote: Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves Speaker: Jaesun Lee (1024)	1028
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15:56~16:14		1021	1054	1049	1048
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16:32~16:50		1030		1078	1063
16:50~17:08		1065			
18:00~20:00	Banquet (Room: **ZEELANDIA 3F**)				

2024/10/5 (Sat) (NEW)

	Room: TAYOUAN A/B 3F
10:00~10:40	**PS4: Plenary Speech 4** Chair: Ching-Chung Yin Title: NDE for Aerospace Composite Structures Speaker: Tsuchin Philip Chu
10:40~11:00	Coffee Break
11:00~11:40	**PS5: Plenary Speech 5** (NEW) Chair: Shyh-Hau Wang Title: Industry 4.1: Intelligent Manufacturing with Zero Defects & Industry 4.2: Green Intelligent Manufacturing for Net Zero Speaker: Fan-Tien Cheng
11:40~13:00	Lunch Time

	Room: TAYOUAN C 3F	Room: NUSANTARIA A 1F	Room: NUSANTARIA B 1F	Room: NUSANTARIA D 1F	Room: NUSANTARIA E 1F	
	EF3: Expert Forum 3 (Chinese) (NEW) Chair: Hsiang-Chieh Chen	**SS6-C: AI (Chinese)** (NEW) Chair: Che-Hwa Yang	**SS4: Guided Waves** Chair: Ping Hung Lee	**UT-C: Ultrasonic Testing (Chinese)** (NEW) Chair: Kun-Yi Tsai, Po Ting Lin	**PC: Poster Competition** (NEW) Judge: Ju-Yi Lee, Peng-Chi Peng	
13:00~13:18	Title: NDT Applications with UAV Speaker: Hsiang-Chieh Chen, Po-Hsun Chen, Kual-Zheng Lee	1005	Keynote: Optimised detection and sizing of pipe corrosion at supports using guided wave technology Speaker: Chien An Chua (1075)	1004	1006 (Chinese)	13:00~13:12
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					1087 (English)	14:24~14:36

	Room: TAYOUAN C 3F	Room: NUSANTARIA A 1F	Room: NUSANTARIA B 1F	Room: NUSANTARIA D 1F	Room: NUSANTARIA E 1F	
	EF4: Expert Forum 4 (Chinese) (NEW) Chair: Peng-Chi Peng	**SS7-C: Civil NDT (Chinese)** Chair: Chia-Chi Cheng	**SS5-C: Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves (Chinese)** Chair: Jia-Hong Sun	**NDT-C: NDT-General (Chinese)** Chair: Jin-Jhy Jeng, Ping Hung Lee	**PS: Poster Session** (NEW) Chair: Po Ting Lin, Chieng Neng Wei	
14:50~15:08	Title: High-Level NDT Technologies for Steel Bridge Applications Speaker: Peng-Chi Peng, Chia-Shun Lee, Chun-Yu Chi, Jeff Liaw	1003	1025	1015	1009 (Chinese)	14:50~15:02
15:08~15:26		1040	1051	1020	1012 (Chinese)	15:02~15:14
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16:02~16:20		1070	1088	1083	1067 (Chinese)	15:38~15:50
					1068 (Chinese)	15:50~16:02
					1080 (Chinese)	16:02~16:14
					1079 (English)	16:14~16:26

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Chinese Sessions	English Sessions	Meals

Updated: 2024/10/1 21:18

Program Schedule

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10:30-12:10	APFNDT AEC Meeting			Nusantaria C 1F	
10:30-10:50	Coffee Break				
10:50-11:30	PS2: Plenary Speech 2	Microwave Real-Time and High-Resolution Imaging System Development for NDT Applications	Chair: Ching-Chung Yin Speaker: Reza Zoughi	Tayouan A/B 3F	27
11:30-12:10	PS3: Plenary Speech 3	Digital Twin – Enabling Technology for Future Aircraft Health Monitoring	Chair: Shyh-Hau Wang Speaker: Fuh-Gwo Yuan	Tayouan A/B 3F	30
12:10-13:30	APFNDT / SNTCT Lunch Meeting			Nusantaria C 1F	
12:10-13:30	Lunch Time				
13:30-15:00	EF1: Expert Forum 1 (Chinese)	Offshore Wind Turbine Maintenance and In-Service Inspection Development	Chair: Pao-Hong Tong Speaker: Pao-Hong Tong, Ren-Rong Chang, Wei-Te Chen, Ryan Chang	Tayouan C 3F	37
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			Glass Holes Based on Shape from Focus Method			
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		1027	Polarization Interferometry for High-Sensitivity Roll Angular Displacement Measurement	Wun-Yan Chen, Han-Hao Tseng, Ju-Yi Lee		86
		1037	Roll and Pitch Angular Displacements Measurement Based on Dual Beam Polarization Interferometry	Shu-Han Chang, Kuan-Yu Hsu, Ju-Yi Lee		86
		1044	Design of an optical-mechanical depth sensing system	Yao-Yuan Chang, Siao-Yu Chang Jian, Jing-Heng Chen, Kun-Huang Chen		87
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		1039	UAV-based Structure Inspection with Automatic Path Planning with Obstacle Avoidance	Pin-Cheng Chen, Ching-Yuan Chang, Kuan-Yen Liu, Po Ting Lin		110
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		1014	Solving 2D Corrosion Mapping Ultrasonic Inspection Challenges	Dennis Chai		122
		1019	Based on Shape from Focus Technology Measuring Internal Modified Layer Thickness of Silicon Carbide	Yu-Chen Kuo, Ji-Ru Jiang, Ju-Yi Lee		123
		1077	Optimizing Payload Capacity and Real-Time Grasping Analysis in Delta Parallel Robots Using PVDF/Graphene Piezoelectric Sensors	Yao-Chung Hsu, Brijesh Patel, Yu-Hsun Chen, Wei-Song Hung, Po Ting Lin		124
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		1018	Non-destructive inspection of filling condition of injection filler using passive infrared thermography	Nobuto Kunisada, Takahide Sakagami, Daiki Shiozawa,		52

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		1035	Lightweight low-frequency resonator for tube vibration isolation	Boris I, Yeongil Choi, Jaesun Lee		54
		1036	Automated detection of defects in composite materials using Multi-Signal Neural Network and PAUT data	Kseniia Barshok, Yeongil Choi, Yongjoon Choi, Jaesun Lee		55
		1081	Analysis of SH-guided wave mode conversion induced by heterogeneous defect geometries in isometric plate	Ambuj Kumar Gautam, Ching-Chung Yin, Bishakh Bhattacharya		56
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		1021	Thermal Imaging of Thin CFRP Plates	Chih-Hung Chiang, Yung-Chiang Lin,		75

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		1030	Fatigue Crack Detection by Low Power Laser Thermography	Yuya Murao, Daiki Shiozawa, Takahide Sakagami		77
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		1049	Study on membrane tensile force of photomask protective membrane for quality evaluation	Yu-Ching Lee, Yuan-Wen Chen		80
		1076	Internal Pipe Defect Inspection Based on Fusion of PVDF/Graphene Piezoelectric Sensor and Magnetic Induction Sensor with Machine Learning	Edmun Iro Kavalo Halawa, Brijesh Patel, Yao-Chung Hsu, Lung-Jenq Wu, Wei-Song Hung, Po Ting Lin		81

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		1031	人工智慧於定量雷射超音波檢測缺陷定位之應用	葉祐良, 黃聖權, 楊哲化		58
		1048	敲擊回音法檢測植筋錨固之回歸曲線分析使用時機之探討	吳姵玟, 余志鵬		59
		1056	應用於非導磁金屬導電率估測之線圈阻抗渦電流感測方法	吳易秦, 藍宥麟, 林峻永		59
		1063	渦電流自動辨識技術	林佑儒		60
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10:40-11:00	Coffee Break				
11:00-11:40	PS5: Plenary Speech 5	Industry 4.1: Intelligent Manufacturing with Zero Defects & Industry 4.2: Green Intelligent Manufacturing for Net Zero	Chair: Shyh-Hau Wang Speaker: Fan-Tien Cheng	Tayouan A/B 3F	34
11:40-13:00	Lunch Time				
13:00-14:30	EF3: Expert Forum 3 (Chinese)	NDT Applications with UAV	Chair: Hsiang-Chieh Chen Speaker: Hsiang-Chieh Chen, Po-Hsun Chen, Kual-Zheng Lee	Tayouan C 3F	41
13:00-14:30	SS6-C: AI (Chinese)	Chair: Che-Hwa Yang		Nusantaria A 1F	96
		1005 非破壞射線檢測人工智慧影像辨識及輔助判片系統之應用	黃炳森, 黃啟貞, Jocelyn		96
		1029 人工智慧於雙層骨骼系統材料參數之預測	黃佳志, 陳禹丞, 楊哲化		97
		1038 基於蘭姆波頻散關係預測材料機械性質的人工智慧系統開發	鄭彥榕, 林元柏, 楊哲化		97
		1066 以深度學習分類敲擊回音時頻圖頻率組成	葉柏涼, 高瑋澤, 劉佩玲		98
		1073 人工智慧助力-提升檢測師判讀的經驗	李秉鴻, 林建凱, 余國禎, 洪鍏, 朱民宏		99

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		Keynote	Optimised detection and sizing of pipe corrosion at supports using guided wave technology (Paper No: 1075)	Speaker: Chien An Chua Author: Chien An Chua, Andrew Zhi Jie Lee, Tomasz Pialucha		46
		1071	Guided Wave Inspection-Wherever the Pipeline Goes, Inspectors Follow	Ping Hung Lee et al.		89
		1074	Beyond Toys-The New Application of LEGO in Electromagnetic Ultrasonic Autonomous Vehicles	Ping Hung Lee et al.		90
		1084	Finite Distance Guided Wave Detection of Rail Defects with Directional Decomposition	Ching-Chung Yin, Tian-Can Feng, Shi-Yi Jhang		90
13:00-14:30	UT-C: Ultrasonic Testing (Chinese)	Chair: Kun-Yi Tsai, Po Ting Lin			Nusantaria D 1F	113
		1004	小管徑金屬管套接銲道相位陣列超音波檢測	李紹喜, 陳慶原, 陳豪韋, 劉昶廷		113
		1008	航太鋁合金擠型件超音波檢測之客戶認證歷程研究	陳世峯, 蕭天文, 洪呈凱		114
		1060	PAUT、TOFD 與 CWUT 對於內表面裂紋檢出能力及分析探討	邱雍惟, 郭榆丞, 黃啟貞		115
		1072	疲勞裂紋的專武-陣列超音波相位相干成像技術	李秉鴻, 朱民宏, 殷菘偉, 李博裕, 謝文棟		115
		1082	非線性超音波用於缺陷幾何形狀偵測	羅裕翔, 馮浚, 尹慶中		116
		Judge: Ju-Yi Lee, Peng-Chi Peng				62

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		1007(Ch)	離岸風電超音波檢測結合無人機內視鏡檢測之應用	洪裕翔		63
		1016(Ch)	音洩檢測技術應用於儲槽洩漏之初探	胡喻柏, 陳建曄, 盧信佑		64
		1033(Ch)	不銹鋼桶槽表面遠端目視影像資料庫與處理系統建置	張佐民, 董曉明		64
		1061(Ch)	電磁式超音波評估電廠管路薄化和材質劣化的創新與應用	林士瑄, 林宏儒, 黃鴻鈞, 吳志成, 蘇逸彥		65
		1086(Ch)	熱交換管裂縫之肇因與檢測探討	鍾明雄, 陳秀易, 葉嘉興		65
		1042(En)	Analysis of Debonding in Adhesive Bonded Structure using Quasistatic Components of Nonlinear Guided Waves: A Numerical Study	Yongjoon Choi, Mohammed Aslam, Jaesun Lee		66
		1087(En)	Comprehensive 360-Degree Automated Optical Inspection for Improved PCB Defect Detection	Chun-Lung Cheng, Jing-Feng Weng		67
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14:50-16:20	EF4: Expert Forum 4 (Chinese)	High-Level NDT Technologies for Steel Bridge Applications		Chair: Peng-Chi Peng Speaker: Peng-Chi Peng, Chia-Shun Lee, Chun-Yu Chi, Jeff Liaw	Tayouan C 3F	43
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		1040	逆擴展有限元素法應用於損傷結構之結構健康監測	戴名駿		106
		1052	超高速傳輸線之線上檢測	蔡博恩, 甘政倫, 李壽南, 劉育翔, 許世明, 何昭慶		106
		1053	智慧工場-應用無人飛行器於儲槽檢測	許博誠, 李秉鴻		107
		1070	陣列式超音波、輔助研判及雲端管理系統在設備管線銲道品質檢查運用	黃宗傑, 蔣政剛, 黃志輝		108
14:50-16:20	SS5-C: Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves (Chinese)	Chair: Jia-Hong Sun			Nusantaria B 1F	92
		1025	應用於縱波超音波換能器之聲子晶體波導研究	孫嘉宏, 周澄複, 陳永裕		92
		1051	防塵組件薄膜於氣壓差負載下擴張現象之研究	蔡煌龍, 李雨青, 林克默		93
		1069	以拓樸最佳化法設計二維寬能隙聲子晶體	鄭博文, 張湘淇, 張怡玲		94
		1085	應用卷積神經網路辨識鐵軌背向散射導波譜圖	張育瑞, 林意宸, 尹慶中		94
		1088	超音波流量計之高溫波導研究	陳泓銘, 尹慶中, 褚柏胤, 曾科穎		95
14:50-16:20	NDT-C: NDT-General (Chinese)	Chair: Jin-Jhy Jeng, Ping Hung Lee			Nusantaria D 1F	117
		1015	各國 NDT 能力試驗活動差異說明	楊智詠, 翁德富		117
		1020	HDPE 套管對鋼鉸線的振動行為造成之影響	鍾保寅, 賴建宏, 余志鵬		118

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		1058	陰影疊紋量測技術用於晶圓翹曲量測之開發	賈皓文, 謝宏麟, 李朱育, 曹庭豪		119
		1083	連續損傷模型應用於航空複材結構損傷預測	梁育瑞		120
14:50-16:26	PS: Poster Session	Chair: Po Ting Lin, Chieng Neng Wei			Nusantaria E 1F	68
		1009(Ch)	離岸風電 TYK 接頭非破壞檢測人才培訓推動紀實	黃柏焜, 顏嘉緯, 鄭偉凡		68
		1012(Ch)	磁漏檢測查驗技術精進	黃伯揚		69
		1043(Ch)	軋輥非破壞檢驗案例	張明弘, 蔡坤義		70
		1064(Ch)	使用疊紋干涉術測量旋轉角度	陳柏翰, 張智翔, 楊喆安, 許正治		70
		1067(Ch)	基於人工智慧的熱交換管缺陷渦電流檢測中支撐板干擾的濾波方法	鄧依庭, 陳鵬宇, 吳維勁, 古運承, 高永浩, 陳彥誠, 郭茂坤, 廖駿偉		71
		1068(Ch)	熱交換管圓周向裂縫訊號辨識技術提升	洪敬傑, 楊家銘		71
		1080(Ch)	單向纖維複合材料裂縫試驗	吳定恩, 江支弘		72
		1079(En)	Modelling a Deep Ultraviolet Light Emitting Diode with a Cubic-Boron-Nitride Electron Blocking Layer	Wen-Chi Liu, An-Chi Wei		73

PS1: Plenary Speech 1

Progress & Development of ISO9712:2021 Certification in the Asia-Pacific Region

Chair: Prof. Ju-Yi Lee, Department of Mechanical Engineering, National Central University, Chungli, Taoyuan, Taiwan (Chairman of Department of Mechanical Engineering, Chairman of Graduate Institute of Energy Engineering)

Speaker: Dr. Sajeesh Kumar Babu (Chairman of the International Committee for NDT (ICNDT), Vienna、President of the Non-Destructive Testing Society, Singapore)
FNDTSS, FHKICA, FCMI, MInstNDT, MIAQP, MHKISC, MIET, MIES, MWELDI, RPE(MIE), CEng (IET, IES)

Email: skbabu@ansagroup.org, chairman@icndt.org, skbabu@ndtss.org.sg

Time: 10/4/2024 Fri 9:50-10:30

Location: Tayouan A/B 3F

Abstract: Non-destructive testing (NDT) is pivotal in upholding the safety, reliability, and efficiency of critical infrastructure and machinery in the Asia-Pacific region, a driving force behind global economic growth. Key industries such as energy including nuclear, petrochemicals, aviation, and civil construction underscore the necessity of certified NDT personnel. Personnel certification is one of the weakest link the quality chain of NDT. This paper provides a holistic overview of NDT personnel certification scheme and progress and development of ISO 9712:2021 certification in the Asia-Pacific region, encompassing their current status, impact on industries, accreditation of international standards, and recognition of potential qualification records. It surveys existing certification schemes in countries/regions like Australia, China, Taiwan, Hong Kong, India, Japan, and Singapore, while also evaluating the recognition of ISO 9712 certification, an international benchmark for ensuring competence and service reliability. Additionally, the paper examines industry acceptance of

these programs. The influence of NDT personnel certification on sectors like petrochemicals, oil & gas, and civil construction is explored, along with measures taken to ensure certification acceptance and challenges tied to ISO 9712:2021 adoption. Furthermore, the presence of national accreditation bodies in the region and their acknowledgment of global certification standards is assessed, underscoring the importance of third-party certification schemes and proposing a region-specific scheme to cater to evolving industry needs. In conclusion, this comprehensive analysis reaffirms the Asia-Pacific region's commitment to safety, reliability, and efficiency in critical industries through NDT personnel certification and the establishment of robust qualification records.

Bio: Dr. Sajeesh BABU has 30 years of International Experience in Energy, Refineries & Petrochemical, Oil & Gas, Building & Construction Industry in Quality Assurance & Control, NDT, Condition Monitoring & Diagnostics Testing. Currently he is holding a position of Quality Director in Rotary Group & CEO of ANSA Holdings, Singapore. He is also the current Chairman of the International Committee for NDT (ICNDT), Vienna & the President of Non-Destructive Testing Society (Singapore). He worked greatly for the promotion of harmonization in NDT personnel certification worldwide in specific to ISO 9712 standards. Dr. Babu obtained his Engineering Doctorate from City University of Hong Kong and obtained his Master of Engineering from University of South Australia. He is a Chartered Engineer from Singapore & UK & Registered Professional Engineer from HK respectively. He is a Qualified ISO 9712 NDT Level 3 & ASNT NDT Level 3. He is a fellow of HKICA, fellow of NDTSS, Honorary member of ICNDT & APFNDT.

PS2: Plenary Speech 2

Microwave Real-Time and High-Resolution Imaging System Development for NDT Applications

Chair: Prof. Ching-Chung Yin, Department of Mechanical Engineering, National Yang Ming Chiao Tung University, Hsinchu, Taiwan (President of The Society for Nondestructive Testing & Certification of Taiwan (SNTCT))

Speaker: Prof. Reza Zoughi, Department of Electrical and Computer Engineering, Iowa State University, Ames, IA, USA (Director of Center for Nondestructive Evaluation)

Email: rzoughi@iastate.edu

Time: 10/4/2024 Fri 10:50-11:30

Location: Tayouan A/B 3F

Abstract: In the past four decades microwave and millimeter wave imaging has experienced a renaissance. The advancing new high-frequency device technologies, advancement in image reconstruction algorithms, evolution of imaging modalities and operational utility especially for nondestructive testing (NDT) applications have collectively contributed to this significant change. These advancements and efforts to so do are expected to continue in the foreseeable future. This presentation gives a brief background on some of the critical works that have helped lay the foundation for these developments. Specifically, contributions to the field since the early 1990s to the present day in developing new imaging methodologies and tools specifically for NDT applications will be discussed. This presentation provides a chronology of certain specific developments and illustrates how the desire to address NDT needs and requirements have kept these developmental processes moving ahead.

Bio: Reza Zoughi received his B.S.E.E, M.S.E.E, and Ph.D. degrees in electrical engineering (radar remote sensing, radar systems, and microwaves) from t he University of Kansas where from 1981 until 1987 he was at the Radar Systems and Remote Sensing Laboratory (RSL). He is the Kirby Gray (Battelle) Chair in Engineering and a Professor Electrical and Computer Engineering (ECpE) at Iowa State University (ISU). He served as the Schlumberger Endowed Professor of Electrical and Computer Engineering at Missouri University of Science and Technology (Missouri S&T) from January 2001 to August 2019. Prior to joining Missouri S&T and since 1987 he was with the Electrical and Computer Engineering Department at Colorado State University (CSU), where he was a professor and established the Applied Microwave Nondestructive Testing Laboratory (amntl). Dr. Zoughi served as the Business Challenge Endowed Professor of Electrical and Computer Engineering from 1995 to 1997 while at CSU.

While at CSU he received nine teaching awards, including the State Board of Agriculture, Excellence in Undergraduate Teaching Award and the Abell Faculty Teaching Award. Since at Missouri S&T he has received seventeen Outstanding Teaching Awards & Commendations. He is the recipient of the 2007 IEEE Instrumentation and Measurement Society Distinguished Service Award, the 2009 American Society for Nondestructive Testing (ASNT) Research Award for Sustained Excellence and the 2011 IEEE Joseph F. Keithley Award in Instrumentation and Measurement. In 2013 he and his co-authors received the H. A. Wheeler Applications Prize Paper Award from the IEEE Antennas and Propagation Society (APS).

He is the author of a textbook entitled “Microwave Nondestructive Testing and Evaluation Principles” KLUWER Academic Publishers, 2000, and the co-author of a chapter on Microwave Techniques in the book entitled “Nondestructive Evaluation: Theory, Techniques, and Applications” Marcel and Dekker, Inc., 2002. He is the co-author of 170 refereed journal papers, 350+conference proceedings and presentations and 118 technical reports.

He served as the Editor-in-Chief of the IEEE Transactions on Instrumentation and Measurement (2007-2011), two terms as an at-large AdCom member of the IEEE Instrumentation and Measurement (I&M) Society, I&M Society President (2014-2015) and serves as an I&M Society

Distinguished Lecturer (2018-2021). He served as the General Co-Chair of the 2013 IEEE Instrumentation and Measurement Technology Conference (I2MTC). He has been elected as an at-large member of IEEE Publications Services & Products Board (PSPB) for two terms, and served on the IEEE TAB/PSPB (2015 & 2017-2019).

He has eighteen issued US patents to his credit (with several issued abroad) in the field of microwave nondestructive testing and evaluation. He has delivered numerous Invited and Keynote presentations on the subject of microwave and millimeter wave nondestructive testing and imaging.

He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a Fellow of the American Society for Nondestructive Testing (ASNT).

PS3: Plenary Speech 3

Digital Twin - Enabling Technology for Future Aircraft Health Monitoring

Chair: Shyh-Hau Wang, Professor in Department of Computer Science and Information Engineering, National Cheng Kung University, Tainan, Taiwan (Chairman of Department of Computer Science and Information Engineering)

Speaker: Fuh-Gwo Yuan, Distinguished Samuel P. Langley Professor and Director of Integrated Systems Management Laboratory at National Institute of Aerospace, USA and a Professor of Mechanical and Aerospace Engineering at North Carolina State University, USA

Time: 10/4/2024 Fri 11:30-12:10

Location: Tayouan A/B 3F

Abstract: The talk will begin with a brief introduction of structural health monitoring (SHM) which has been attracting intensive attention since early 1990s. An essential difference between sensor centric SHM and nondestructive evaluation (NDE) will be highlighted. Advances in smart sensors powered by energy harvesting via ambient vibrations will be exemplified by two practical case studies. Recent advances in computer vision based SHM techniques using optical non-contact sensors with machine learning to detect impact loading and barely visible impact damage (BVID) in composite panels will be discussed in details. Finally, the digital twin framework under digital transformation and artificial intelligence (AI) is gaining potential to pave the way for future aircraft health monitoring.

Bio: Prof. Fuh-Gwo Yuan received his Ph.D. degree in Theoretical and Applied Mechanics from the University of Illinois at Urbana-Champaign, USA in 1986. Prof. Yuan currently is a Distinguished Samuel P. Langley Professor and Director of Integrated Systems Management Laboratory at National Institute of Aerospace, USA and a Professor of Mechanical and Aerospace Engineering at North Carolina State University, USA. Dr. Yuan also has held several prestigious positions such as Yushan Fellow Professor in the Department of Engineering Science at National Cheng Kung University, Taiwan; Distinguished Scholar at Czech Technical University, Prague, Czech Republic ; Visiting Fellow at Magdalen College, University of Oxford; and Director, Mars Mission Research Center, NCSU.

Prof. Yuan received Fellow of The Royal Aeronautical Society; Fellow of The International Society for Optics and Photonics (SPIE); Fellow of The American Society of Mechanical Engineers (ASME); 2023 SHM Hans-Juergen Schmidt Award; 2023 R. J. Reynolds Tobacco Company Award, North Carolina State University; 2023 Lifetime Achievement Award in Nondestructive Evaluation (NDE), International Society for Optics and Photonics (SPIE) and many more. He also served in the Editorial Positions in several journals such as International Journal of Sustainable Materials and Structural Systems, AIAA Journal, Journal of Structural Health Monitoring, ASCE, Journal of Energy Engineering, etc.

Prof. Yuan has more than 300 publications in composite materials and structures, nondestructive inspection (NDI), machine learning, smart sensors/actuators, structural health monitoring (SHM). He advised 40 Ph.D., 36 M.S. and over 40 visiting scholars.

PS4: Plenary Speech 4

NDE for Aerospace Composite Structures

Chair: Prof. Ching-Chung Yin, Department of Mechanical Engineering, National Yang Ming Chiao Tung University, Hsinchu, Taiwan (President of The Society for Nondestructive Testing & Certification of Taiwan (SNTCT))

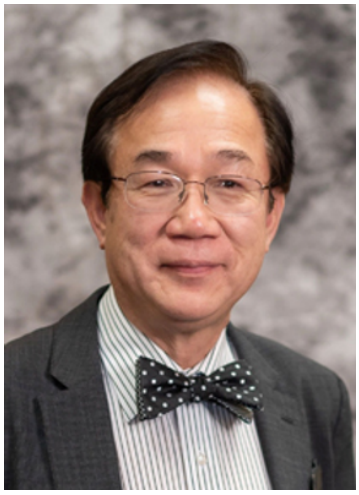
Speaker: Tsuchin Philip Chu, Professor in the School of Mechanical, Aerospace, and Materials Engineering and the Director of the Engineering Science PhD Program at Southern Illinois University Carbondale (SIUC)

Time: 10/5/2024 Sat 10:00-10:40

Location: Tayouan A/B 3F

Abstract: Composite materials have been widely adopted in the aerospace industry due to their excellent strength-to-weight ratios and customizable properties. However, the complex nature of these materials presents significant challenges for quality assurance and defect detection. To address these challenges, various nondestructive evaluation (NDE) methods have been developed, including ultrasonics, acoustic emission, laser shearography, infrared thermography, X-ray, and digital image correlation. These techniques facilitate the detection of critical flaws such as matrix cracking, delamination, and voids, ensuring the safety and reliability of composite structures without causing damage.

This presentation reviews the key NDE techniques used in aerospace composite inspections, highlighting their operating principles, advantages, limitations, and specific applications. Specific applications will be explored to illustrate the practical use of these techniques in the field, including detailed case studies of inspections conducted on the Space Shuttle, assessments of composite bondlines, evaluations of carbon-carbon aircraft brakes, and the monitoring of composite aircraft panel repairs. Through these examples, we aim to showcase the critical role that NDE plays in ensuring the safety, reliability, and longevity of aerospace structures.



Bio: Tsuchin “Philip” Chu is a professor in the School of Mechanical, Aerospace, and Materials Engineering and the Director of the Engineering Science PhD program at Southern Illinois University Carbondale (SIUC). His 40-year research portfolio encompasses areas such as NDE, additive manufacturing (AM), biomedical engineering, experimental mechanics, and composite materials.

Professor Chu is widely recognized as a pioneer of digital image correlation (DIC) and is actively engaged in the cutting-edge research in NDE. His current focus includes the innovative application of AI/ML techniques for NDE in AM processes. He has authored and co-authored over 150 peer-reviewed journal publications and conference proceedings. He is an ASNT Fellow (class of 2019) and has received multiple ASNT Faculty and Fellowship Grants. Notable awards include the ASNT Mentoring Award in 2014, Lester/Mehl Honor Lecture in 2019, and the ASNT Research Recognition for Sustained Excellence in 2023. In addition to his academic contribution, Dr. Chu serves as a subject matter expert for the NASA Engineering and Safety Center NDE Technical Disciplinary Team. He is also a co-founder of Clipius and ISAT LLC, both think-tank companies focused on producing intellectual property in the areas of defense and aerospace sectors.

PS5: Plenary Speech 5

Industry 4.1: Intelligent Manufacturing with Zero Defects & Industry 4.2: Green Intelligent Manufacturing for Net Zero

Chair: Prof. Shyh-Hau Wang, Department of Computer Science and Information Engineering, National Cheng Kung University, Tainan, Taiwan (Chairman of Department of Computer Science and Information Engineering)

Speaker: Chair Prof. Fan-Tien Cheng, Graduate Institute of Manufacturing Information and Systems, National Cheng Kung University, Tainan, Taiwan (Director of Intelligent Manufacturing Research Center)

Email: chengft@mail.ncku.edu.tw

Time: 10/5/2024 Sat 11:00-11:40

Location: Tayouan A/B 3F

Abstract: Industry 4.0 defined the goal of Digital Transformation, aiming to enhance Productivity. On the other hand, the core of Industry 4.1 is to realize Intelligent Manufacturing with Zero Defects, which is used to resolve production quality issues that receive relatively little attention in Industry 4.0 and achieve the goal of not producing defective products. Further, developing the advanced technologies of Energy Saving and Carbon Reduction based on the Industry 4.1 platform can assist various industries to realize not only Digital Transformation but also taking Energy Conservation and Carbon Reduction into account. In this way, the goal of net zero carbon emissions (Net Zero) in 2050 can be accelerated for international competitiveness and sustainable development. This state is the so-called Industry 4.2—Green Intelligent Manufacturing for Net Zero (I4.2-GiM).

Bio: Fan-Tien Cheng (Life Fellow, IEEE) received the B.S. degree from National Cheng Kung University (NCKU), Tainan, Taiwan, in 1976, and the master's and Ph.D. degrees from The Ohio State University, Columbus, OH, USA, in 1982 and 1989, respectively. After his graduation of the B.S. degree in 1976, he started to work at the Chung-Shan Institute of Science and Technology (CSIST), Ministry of National Defense, Taoyuan, Taiwan, until 1995. He then began his academic career at the Institute of Manufacturing Engineering and the Department of Computer Science, NCKU. He had been a Chair Professor with NCKU from 2009 to January 2024; and he has become a Professor Emeritus at NCKU and a research fellow and CEO of iMRC since February 2024 after his retirement. He has dedicated himself to applying the technologies of automation and system integration that he learned at CSIST to the Intelligent Manufacturing of both high-tech and traditional industries to exceed Industry 4.0 so as to reach the goal of Industry 4.1, meaning zero defects of all products.

Dr. Cheng received major honors and awards domestically and internationally: the 2011 Award for Outstanding Contributions in Science and Technology from the Executive Yuan; the National Science Council (NSC) Outstanding Research Awards for three times in 2006, 2009, and 2013; the National Invention and Creation Award for three times in 2011, 2012, and 2018; the 2008 University Industry Economy Contribution Award–Individual Award from Ministry of Economic Affairs (MoEA); the Outstanding Industry-University-Cooperation (IUC) Award from the Ministry of Education in 2003; the 2010 TECO Award from the TECO Technology Foundation; the 2014 Outstanding Research Award from the Pan Wen Yuan Foundation; the 2014 K.-T. Li Science and Humanities Chair-Honorary Scholar Award; the 20th Outstanding Achievement Award from the Phi Tau Phi Scholastic Honor Society in 2015; the 2013 IEEE Inaba Technical Award for Innovation Leading to Production (for contributions to the development of the AVM System); the IEEE ICRA Best Automation Paper Award for two times in 1999 and 2013; the IEEE CASE Best Application Paper Award in 2017; the IEEE ICRA 2018 Best Paper in Automation—Finalist; the Chinese Institute of Automation Engineers (CIAE) Award in 2022; and the Merit National Science and Technology

Council (NSTC) Research Fellow in 2023. He was the 11th and 12th terms' President of the Chinese Institute of Automation Engineering (2017-2020). He was the Program Chair of the IEEE CASE 2014 and the Award Chair of CASE 2016 and ICRA 2017. He has been a Senior Editor of the IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING from October 2017 to December 2022. He has also been the Steering Committee Chair of IEEE International Conference on Automation Science and Engineering (CASE) since August 2020.

EF1: Expert Forum 1 (Chinese)

Offshore Wind Turbine Maintenance and In-Service Inspection Development

Chair and Speaker: Pao-Hong Tong

Speaker: Ren-Rong Chang

Speaker: Wei-Te Chen

Speaker: Ryan Chang

Time: 10/4/2024 Fri 13:30-15:00

Location: Tayouan C 3F

Speaker	Presentation Title
Ren-Rong Chang	台灣離岸風電 NDT 技術應用發展現況
Ren-Rong Chang	國際離岸風電標準及運維階段認證介紹
Wei-Te Chen	台灣離岸風場運維檢測技術與認證未來發展
Ryan Chang	離岸風場運維檢測業務承攬商技術能力需求

離岸風電為 2050 淨零轉型 12 項關鍵戰略重要選項，政府透過三階段(示範獎勵、潛力場址、區塊開發)政策，逐步 穩健推動離岸風力發展，達成 2025 年 5.6 GW，2035 年 20.6 GW，2050 年 40-55 GW 的政策目標。2024 年經濟部報告臺灣 2023 年離岸風電成績已完成 2.25 GW 風場建置，除了在亞太地區民主國家領先，更是世界上少數離岸風電突破 2GW 的國家。

國內首座離岸風場海洋風電（128 MW）於 2019 年 11 月 12 日正式啟動，台電一期示範風場（109.2 MW）於 2021 年 8 月完工併聯，海能風場（378 MW）於 2023 年 3 月全數完工併聯。允能風場（360 MW）、彰芳西島風場（600 MW）、沃旭能源的大彰化東南、西南風場(900 MW）與中能風場(294.5 MW)亦陸續於 2023 -2024 年完工。

本座談由專家分享非破壞檢測技術在台灣離岸風電風場建設階段的貢獻以及討論台灣離岸風電風場的運維檢測未來發展，以協助國

內非破壞檢測業者與學者了解未來技術與業務發展趨勢，推動離岸風電運維非破壞檢測的國產化。各主題摘如下：

(1)台灣離岸風電 NDT 技術應用發展現況：

介紹台灣非破壞檢測協會與興達海基合作，推展非破壞檢測人員資格符合 ISO 9712 國際認證，以配合離岸風電工程國產化工程的過程，另外中能與興達海基公司也協助非破壞檢測協會推動 PAUT 與 TOFD 兩項檢測技術的人員訓練與資格檢定，以滿足未來離岸風電未來運維檢測的技術人力需求。

(2) 國際離岸風電標準及運維階段認證介紹：

因為離岸風電設備檢測為海上作業，必須有非常嚴格的海事工程認證管理以降低作業風險及確認檢測品質，由離岸風電國際標準的主要認證推動機構 DNV 介紹，國際上離岸風電運維管理與檢測技術認證制度目前的現況以及未來發展，以引導欲投入未來離岸風電運維檢測的技術人員及業者，做好技術認證準備。

(3)台灣離岸風場運維檢測技術與認證未來發展：

離岸風電風機運維檢測的業務項目非常多且複雜，除了人員以高空或潛水作業執行檢測外，近年搭配無人載具執行檢測已逐漸普遍，政府設立海洋科技創新中心開發離岸風電檢測技術及執行技術驗證已漸有成果，透過整合與認可國內檢測技術能量，為離岸風電未來運維檢測建立基礎。

(4)離岸風場運維檢測業務承攬商技術能力需求：

風睿能源為台灣國內少數離岸風電經營廠商，除了繼續參與國內與國外新的離岸風場開發案，也擁有國內海洋風電與海能風場的營運經驗。由於離岸風機的設備維護保養與檢測成效對於營運經濟效益影響重大，執行運維檢測的承攬商與技術人員必須取得風場開發商信賴，風睿分享離岸風場實際檢測需求與國內檢測公司如何取得技術能力認可。

EF2: Expert Forum 2 (Chinese)

CNS National Standard Maintenance and Taiwan ISO 9712 Certification

Chair/Speaker: Yung-Shun Su (General Manager at The Society for Nondestructive Testing & Certification of Taiwan / NDT Level III)

Speaker: Kent Cheng (The Society for Nondestructive Testing & Certification of Taiwan)

Speaker: Pao-Hong Tong (Member of CNS Technical Committee/Member of Association Certification Standards Committee / Deputy General Manager of Xingda Marine Structure / Nondestructive Testing Level 3)

Time: 10/4/2024 Fri 15:20-16:50

Location: Tayouan C 3F

<table>
<tr><th>Speaker</th><th>Presentation Title</th></tr>
<tr><td>Yung-Shun Su</td><td>題目：國家標準維護
發展狀況說明：數十年前協會協助標準檢驗局制修訂非破壞檢測相關標準後，即未再參與；標檢局於民國 109 年核定協會為認可標準化團體，參與並配合檢討相關國家標準制修訂作業提案。基於既往及現況考量，總體架構整合為壓力容器(ASME)、鋼結構(AWS)、離岸風電(ISO)及其他(ASTM、JIS、…)四大體系。</td></tr>
<tr><td>Kent Cheng</td><td>國家標準維護(民國 108 年起)：
<table>
<tr><th>項次</th><th>項目</th><th>分類</th><th>總數</th><th>提案數</th></tr>
<tr><td>001</td><td>既有現行</td><td>修訂</td><td>64</td><td>25</td></tr>
<tr><td>002</td><td>離岸風電(ISO)</td><td>制定</td><td>42</td><td>15</td></tr>
</table>
後續規劃：
● 原則：標檢局計畫核定及合約
● 近期：每年 5 件</td></tr>
</table>

<table>
<tr>
<td>Pao-Hong Tong</td>
<td>
題目：ISO 9712 與國內授證制度現況

ISO 9712:2021 發布實施，2023 年協會(SNTCT-CQ-001)完成轉版及 TAF 異動認證。
2024 年驗證統計：

<table>
<tr><td rowspan="2">項次</td><td rowspan="2">項目</td><td colspan="3">統計</td></tr>
<tr><td>I</td><td>II</td><td>III</td></tr>
<tr><td>01</td><td>資格檢定合格率%</td><td>筆試 82.3
實作 60.6</td><td>筆試 77.8
實作 57.1</td><td></td></tr>
<tr><td>02</td><td>持證人數</td><td>558</td><td>1214</td><td>76</td></tr>
</table>

換證及重新驗證

辦理
驗證選項
結構化計點之計算

證書之暫時終止／終止與恢復

</td>
</tr>
</table>

EF3: Expert Forum 3 (Chinese)

NDT Applications with UAV

Chair/Speaker: Prof. Hsiang-Chieh Chen, Department of Mechanical Engineering, National Central University

Speaker: Dr. Po-Hsun Chen, Industrial Technology Research Institute

Speaker: Dr. Kual-Zheng Lee, Delta Research Center

Time: 10/5/2024 Sat 13:00-14:30

Location: Tayouan C 3F

Speaker	Title and Abstract
Prof. Hsiang-Chieh Chen	Title: 以無人機進行大型設施表面瑕疵之檢測與飛行控制 Abstract: 多旋翼無人機具備靈活的飛行能力，搭配高解析度的攝影設備後，便有機會可應用於建築設施表面瑕疵檢測中。無人機可以快速且安全地檢查高層建築、橋梁、風力發電機等大型設施，避免人員攀爬或其他高風險操作。所擷取之影像數據可透過視覺辨識技術進行瑕疵分析，如裂縫、腐蝕或剝落等為常見的瑕疵樣態，藉此提升大型設施的瑕疵檢測效率及準確度。此外，檢測執行時的飛行控制技術讓無人機可沿著飛行路徑安全飛行，更有機會輔以視覺及多重感測技術，進行更智能化的檢測與自主飛行。
Dr. Po-Hsun Chen	Title: 光譜無人機於智慧農業之應用 Abstract: 光譜遙測技術在國內外環境檢測或國土檢測等相關應用已行之有年。過去這種非接觸/非破壞之遙測技術以衛星影像為主要分析標的。但近年來，無人機的興起與高光譜載具的微型化讓商業用途之遙測方式起了重大的改變。尤其是高光譜在農業上之應用需求更能凸顯其重要性。本議題-光譜無

	人機於智慧農業之應用會從光譜基本技術到農業應用的影像解析做初步的說明與分享
Dr. Kual-Zheng Lee	Title: 無人機 AI 橋梁巡檢方案 Abstract: 台達研究院發展自動化巡檢方案，運用無人機自動拍攝橋梁影像並進行數位化管理，期提升巡檢作業效率及安全性。方案特色如下： 一、精準攝影：透過視覺定位於橋底弱 GNSS 環境下自動飛行，並可將興趣點聚焦於畫面中。 二、AI 影像辨識：支援螺栓、銹蝕、油漆剝落、裂縫、土石剝落、鋼筋外露、白華、水痕等8種劣化之 AI 辨識功能，可量測其長度與面積。 三、3D 視覺化管理：具橋梁、無人機、飛行任務等管理功能，支援 3D 瀏覽可標示拍攝點位、劣化區域、橋梁里程等，並產製巡檢數據以輔助橋梁健康度評估。

EF4: Expert Forum 4 (Chinese)

High-Level NDT Technologies for Steel Bridge Applications

Chair and Speaker: Peng-Chi Peng

Speaker: Chia-Shun Lee

Speaker: Chun-Yu Chi

Speaker: Jeff Liaw

Time: 10/5/2024 Sat 14:50-16:20

Location: Tayouan C 3F

Speaker	Presentation Title
Peng-Chi Peng	台灣鋼結構技術之發展
Chia-Shun Lee	淡江大橋工地銲接應用 PAUT 於對接銲道檢測案例
Chun-Yu Chi	相位陣列超音波技術(PAUT)檢測應用與發展
Jeff Liaw	國道 3 號高屏溪斜張橋自動磁漏機械(MFL)檢測案例

國內鋼結構工程領域主要包括建築、橋梁與風電等三大領域，並帶動民生工業與國家經濟長期發展。鋼結構具備耐震佳、工期短與造型佳等優勢，近期成為高層建築與大跨度橋梁首選。台灣地狹人稠且位處太平洋地震帶，地震長期所造成災害，更讓台灣深刻體會鋼結構之重要性與必要性。本座談將介紹台灣鋼結構技術之發展，以因應鋼結構產業價值。

淡江大橋為全世界最大跨距單塔不對稱斜張橋，採用 ASTM A709 Gr. 50W 及 HPS 70W 高功能耐候鋼材，全橋用鋼梁 3 萬多噸，採全電銲斜張鋼結構箱型工法，全滲透銲道除 VT 及 UT 全檢外，考量銲接品質、檢測時效性及現場人員輻防安全，針對主要承受拉力之部分對接銲道應用 PAUT 取代原設計 RT 檢測，並分享 PAUT 首次應用於國際指標橋梁銲接檢測成效。

相位陣列(Phased-array)技術實現工業超音波多樣掃描和視覺化影像，國內多應用於銲道品質、幾何形狀複雜工件及局部範圍掃描檢測，可提升瑕疵檢出能力和訊號判釋效率，改善傳統超音波檢測限制，並開啟 NDT 工程應用新頁。隨著相位陣列超音波技術(PAUT)演進和應用獲得認可，諸如 ISO、ASME、API、AWS 等國際規範已列入法規本文，允許使用 PAUT 取代 RT 檢驗，且本質安全上無輻射危害及防護需求，使 PAUT 具深入、廣為推展價值。本座談將介紹 PAUT 技術發展，以及應用於鋼結構鋼材、銲道、鋼廠製程設備檢測案例。

國道 3 號高屏溪斜張橋為鋼構與預力混凝土複合式構造橋梁，主跨徑達 330 公尺，施工階段佈設完善監測系統，1999 年完工時為亞洲最長非對稱型單橋塔斜張橋。高公局鑑於監測系統未能提供斜張鋼纜詳細檢測資訊遂進行總體檢作業，除目視檢測、揚起試驗和超音波檢驗，並採用影像及磁漏機械自動化檢測技術，同時對鋼纜進行 end to end 全檢，檢測後進行相關改善工作，撰寫斜張鋼纜維護及檢查手冊，納入高公局橋梁管理系統標準作業。本座談將介紹自動磁漏檢測技術(MFL)原理、機械設計概念、使用方式，以及國內外應用案例。

Keynote of SS1: Infrared Thermography

Development of NDT & E Techniques for Long-Span Steel Bridges Based on Multi-Wavelength Infrared Measurements

Chair: Chih-Hung Chiang

Speaker: Takahide Sakagami

Author: Takahide Sakagami*, Daiki Shiozawa

Department of Mechanical Engineering, Kobe University, 1-1 Rokkoudai, Nada-ku, Kobe-city, Hyogo, 657-8501, Japan

*Corresponding Author: sakagami@mech.kobe-u.ac.jp

Time: 10/4/2024 Fri 15:20-15:56

Location: Nusantaria A 1F

Predictive maintenance and condition-based maintenance are becoming more important to ensure the safety of aging infrastructures. Infrared imaging is useful for efficient inspection of a wide range of structures. A nondestructive testing technique using thermal infrared temperature measurement was developed to detect fatigue cracks in large steel structures based on the temperature distribution anomaly, appearing at fatigue cracks due to the thermal insulation effect. Further nondestructive evaluation methods were developed for fatigue cracks to evaluate the structural integrity. On-site stress distribution measurements were conducted by the thermoelastic stress analyses under actual loading conditions. The fracture mechanics approach was adopted for measured stress distribution data to evaluate structural integrity. In addition, nondestructive testing techniques that utilize transmission / absorption characteristics of infrared light in a specific wavelength range were developed. A remote noncontact monitoring technique was developed using a short wavelength infrared camera for early deterioration detection of anticorrosion paint coating employed for steel bridges. This presentation will introduce some application results from the above-mentioned techniques.

Keynote of SS4: Guided Waves

Optimised detection and sizing of pipe corrosion at supports using guided wave technology

Chair: Ping Hung Lee

Speaker: Chien An Chua

Paper Number: 1075

Author: Chien An Chua*, Andrew Zhi Jie Lee, Tomasz Pialucha

Guided Ultrasonics Ltd, Wavemaker House, Unit 3, Brentwaters Business Park, The Ham, Brentford, London, TW8 8HQ, United Kingdom

*Corresponding Author: chien.chua@guided-ultrasonics.com

Time: 10/5/2024 Sat 13:00-13:36

Location: Nusantaria B 1F

Corrosion under pipe supports (CUPS) represents one of the most prevalent pipe defects encountered across oil, gas, and petrochemical facilities, posing serious risks of pipeline structural failure and ultimately product containment loss. Despite being external in nature, locating CUPS remains a formidable task due to the sheer number of pipe supports per pipeline, often numbering in the hundreds. Conducting visual testing for each support proves impractical, particularly when pipes are elevated on racks or insulated. This paper introduces an optimized methodology for CUPS detection and sizing. This approach integrates a broadband guided wave screening technique which complies to ASTM E2775-16, ensuring reliable detection of CUPS over extensive pipe lengths. Additionally, an accurate guided wave scanning technique is employed for precise quantification of the remaining pipe wall thickness at corrosion sites.

The efficacy of this method is demonstrated through inspection results obtained from an 8-inch pipeline situated on a pipe rack within a petrochemical complex, identified as a critical asset by its owner. These results showcase the early detection of several CUPS defects and provide

insights into the extent of damage in terms of remaining pipe wall thickness. Through the synergistic utilization of guided wave screening and scanning techniques, this methodology offers a robust solution for enhancing CUPS detection and facilitating proactive maintenance strategies within industrial facilities.

Keynote of SS5: Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves

Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves

Chair: Po Ting Lin

Speaker: Jaesun Lee

Paper Number: 1024

Author: Boris I[1], Mohammed Aslam[2], Jaesun Lee[3,*]

[1]Department of Smart Manufacturing, Changwon National University, 20 Changwondaehak-ro, Changwon, Rep. of Korea

[2]Extreme Environment Design and Manufacturing Engineering Innovation Centre, Changwon National University, 20 Changwondaehak-ro, Changwon, Rep. of Korea

[3]School of Mechanical Engineering, Changwon National University, 20 Changwondaehak-ro, Changwon, Rep. of Korea

[*]Corresponding Author: jaesun@changwon.ac.kr

Time: 10/4/2024 Fri 15:20-15:56

Location: Nusantaria D 1F

The study and application of metamaterials for elastic guided waves have opened new perspectives across various fields, significantly advancing both theoretical and practical aspects of wave manipulation. Recent research on phononic crystal-based meta-structures for linear and nonlinear guided waves has yielded promising results, capturing the attention of both academia and industry. Our investigation, as discussed in this paper, focuses on optimizing phononic crystal (PC) designs using a numerical approach that considers temperature effects, thereby making them viable as differential temperature sensors. Additionally, another study explores

vibration isolation for tube structures, highlighting the effectiveness of phononic crystals in such applications. The paper also discusses the application of meta-structures for improving nonlinear-based ultrasonic testing, which enhances the isolation of system harmonics to increase sensitivity in damage detection.

Keynote of SS7: Civil NDT

Revolutionizing Infrastructure Management with NDT

Chair: Chair Prof. Chia-Chi Cheng, Department of Civil and Construction Engineering, Chaoyang University of Technology, Taichung, Taiwan (Chair, Center for Non-Destructive Testing, Chaoyang University of Technology)

Speaker: Prof. Tomoki Shiotani, IAC (Office of Institutional Advancement & Communications), Kyoto University, Kyoto, Japan (Deputy Leader, Consortium of Innovative Technique for Infrastructures, Kyoto University)

Email: shiotani.tomoki.2v@kyoto-u.jp

Time: 10/4/2024 Fri 13:30-14:06

Location: Nusantaria B 1F

Abstract: The maintenance of aging infrastructure, particularly in regions like Japan, has become critical due to growing maintenance demands and limited resources. In this paper, we propose innovative non-destructive testing (NDT) solutions that tailor to the risk levels of different infrastructures. For low-risk, remote areas, we employ energy-harvesting sensors for binary condition assessment. High-risk urban areas, on the other hand, require detailed damage visualization, achieved using elastic wave sensors. These sensors were applied to both the construction and in-service phases of a concrete bridge deck, demonstrating their effectiveness in crack detection and structural integrity assessment. The results emphasize the need for adaptive NDT strategies, optimized resource allocation, and integration of internal data with surface-level information for comprehensive infrastructure health assessment.

Bio: Tomoki Shiotani received his B.E. and M.E. degrees from The University of Tokushima and was awarded a Ph.D. from Kumamoto University. He is currently a Professor in the Office of Institutional Advancement and Communication at Kyoto University and serves as the Deputy Leader of the Consortium of Innovative Techniques for Infrastructures at the same institution.

From 2014 to 2022, he was a Professor at the Laboratory on Innovative Techniques for Infrastructure (ITIL) in the Department of Civil and Earth Resources Engineering, Graduate School of Engineering, Kyoto University. During the same period, he also served as the Vice Director of the Infra-System Management Research Unit at the Center for the Promotion of Interdisciplinary Education and Research, Kyoto University.

He is the Chairman of the Technical Committee on "Quality and Performance Assurance of Additively Manufactured Cementitious Composites by Advanced Non-Invasive Techniques" at the International Union of Laboratories and Experts in Construction Materials, Systems, and Structures (RILEM). Additionally, he is the President of the International Institute of Innovative Acoustic Emission and has been the Vice President of the International Society of Acoustic Emission since 2017. He also chaired the Research & Technical Committee on Acoustic Emission at the Japanese Society of Non-Destructive Testing (JSNDI) from 2014 to 2018.

Through these organizations and institutes, Professor Shiotani has conducted extensive research on health monitoring and non-destructive testing (NDT) using innovative techniques such as fiber optical sensing, acoustic emission (AE), ultrasonic, and impact elastic wave methods. His recent work encompasses a wide variety of structural components and materials, including monitoring and evaluating rock slope failures, diagnosing earthquake-damaged concrete piles and bridge piers, assessing repairs and strengthening of gravity dams, and evaluating fatigue damage in reinforced concrete road structures.

EOC: English Oral Competition

Time: 10/4/2024 Fri 13:30-15:00

Judge: Jiunn-Woei Liaw, Jia-Hong Sun, Juin-Fu Chai

Time	Title		Author	Location
13:30-13:48	1018	Non-destructive inspection of filling condition of injection filler using passive infrared thermography	Nobuto Kunisada, Takahide Sakagami, Daiki Shiozawa, Kunpei Ito, Takashi Iizuka	Nusantaria E 1F
13:48-14:06	1026	To Evaluate the Degradation of Heat Damaged HAC Mortar Specimens Using Non-Linear Ultrasound Technique	Kuang-Chih Pei, Yu-Cheng Kan, Yu-Ju Lin	
14:06-14:24	1035	Lightweight low-frequency resonator for tube vibration isolation	Boris I, Yeongil Choi, Jaesun Lee	
14:24-14:42	1036	Automated detection of defects in composite materials using Multi-Signal Neural Network and PAUT data	Kseniia Barshok, Yeongil Choi, Yongjoon Choi, Jaesun Lee	
14:42-15:00	1081	Analysis of SH-guided wave mode conversion induced by heterogeneous defect geometries in isometric plate	Ambuj Kumar Gautam, Ching-Chung Yin, Bishakh Bhattacharya	

Time: 10/4/2024 Fri 13:30-13:48

Location: Nusantaria E 1F

Paper Number: 1018

Non-destructive inspection of filling condition of injection filler using passive infrared thermography

Nobuto Kunisada[1,*], Takahide Sakagami[1], Daiki Shiozawa[1], Kunpei Ito[2], Takashi Iizuka[2]

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In automotive structural components, the weight of structural members is reduced by filling the cavities in the body frame with foam filler to improve fuel efficiency, dynamic performance and riding comfort. In this study, a passive infrared thermography method was applied as a nondestructive inspection method for inline inspection of the filling condition of form filler, based on the measurement of the temperature change on the surface of structural members caused by the reaction heat generated when the filler is foamed. The feasibility of the proposed method was experimentally confirmed using laboratory specimens.

Time: 10/4/2024 Fri 13:48-14:06

Location: Nusantaria E 1F

Paper Number: 1026

To Evaluate the Degradation of Heat Damaged HAC Mortar Specimens Using Non-Linear Ultrasound Technique

Kuang-Chih Pei[1,*], Yu-Cheng Kan[2], Yu-Ju Lin[3]

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In the previous study, nonlinear ultrasonic technology (NLU) was used to evaluate heat damaged cement mortar (NC) specimens with obvious nonlinear characteristics. Good preliminary results were obtained. In this study, the same experiment would be conducted on the high alumina cement mortar (HAC) using CA-50 type cement. The mortars of three water cement ratio (w/c ratio, 0.4, 0.5 and 0.6) were molded into the cube and brick specimens, which would be grouped to get heat damage at six different temperatures. After 28-day curing, mechanical tests were carried out on the cubes to figure out their stress-strain relations and strengths. NLU tests were conducted on the saturated brick specimens for the harmonic generation experiments, where the RITEC SNAP System with 250/500 kHz transmit/receive transducers was used. The obtained amplitudes in spectrum of fundamental, 2nd

and 3rd harmonics would be analyzed to get the trends of nonlinear parameters such as β and γ of each specimen. Which could indicate the condition of microstructure. The comparison between NC and HAC test results could also reveal some particulars of HAC. The NLU showed a promised quantification method on nonlinearity, and its related applications would be interested.

Time: 10/4/2024 Fri 14:06-14:24

Location: Nusantaria E 1F

Paper Number: 1035

Lightweight low-frequency resonator for tube vibration isolation

Boris I[1], Yeongil Choi[1], Jaesun Lee[2,*]

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[2]School of mechanical engineering, Changwon National University

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A traditional passive solution for vibration isolation for low frequencies involves increasing mass to minimise the vibration amplitude, which is unacceptable in many cases. One case is small copper tubes, where increased mass can bend the tube, leading to failure. One of the solutions is resonators, which showed a so-called bandgap: a fascinating ability to create a forbidden frequency range where elastic waves do not exist. Designing the resonator makes creating a bandgap at extremely low frequencies possible. The presented research used the resonator to create a bandgap at 100-150 Hz frequencies. The resonator was treated as a phononic crystal to calculate the dispersion curve, which showed the multiple bandgaps and experimentally proved the bandgap's existence at predicted frequencies. Overall, a single resonator showed -32 dB attenuation at bandgap frequencies and seems promising for vibration isolation, with the potential to adjust the bandgap frequencies and shift it to the <100 Hz range.

Time: 10/4/2024 Fri 14:24-14:42
Location: Nusantaria E 1F
Paper Number: 1036

Automated detection of defects in composite materials using Multi-Signal Neural Network and PAUT data

Kseniia Barshok[1], Yeongil Choi[1], Yongjoon Choi[1], Jaesun Lee[2,*]
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[2]School of Mechanical Engineering, Changwon National University
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This paper presents a novel approach for automatic defect detection in composite materials using phased array ultrasonic testing (PAUT) data, utilizing a real-world dataset. The method leverages a Multi-Signal Classifier (MSC) neural network architecture with an integrated attention mechanism, effectively addressing the complexities inherent in composite materials by processing signals collectively and considering inter-signal relationships. To create the dataset, a specialized toolset was developed to extract and process PAUT data from OPD files, improving the preparation of data for further analysis. The neural network, trained on large number of real-world samples, demonstrated high performance in predicting defect locations when evaluated on additional test data. Additionally, an algorithm was developed to estimate defect depth by comparing defective signals with a reference signal derived from healthy signals. While the depth estimation approach showed potential, it encountered challenges in regions with high variation in reflections, leading to false positives. So, further development of a more robust defect depth estimation method, possibly involving another neural network model, is recommended. This research provides a solid foundation for automating defect detection in composite materials, with significant potential for application in industries where material integrity is critical.

Time: 10/4/2024 Fri 14:42-15:00
Location: Nusantaria E 1F
Paper Number: 1081

Analysis of SH-guided wave mode conversion induced by heterogeneous defect geometries in isometric plate

Ambuj Kumar Gautam[1,2,*], Ching-Chung Yin[3], Bishakh Bhattacharya[2]

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This study explores the mode conversion phenomena in guided wave modes (SH0 and SH1) induced by several heterogeneous defect geometries on a metal plate, including multi-stepped rectangular, curved, and tapered forms. The presented work aims to provide insight into how these defects impact mode conversion efficiency, with particular emphasis on how they affect the reflection and transmission coefficients of SH0 and SH1 modes. These findings highlight significant variations in mode conversion patterns and efficiency, providing essential detail for guided wave defect characterization. To offer a quantitative understanding of these impacts, a thorough numerical simulation has been carried out. Furthermore, the experimental validation has been performed using a newly developed chevron electromagnetic acoustic transducer (EMAT) designed specifically for generating SH-guided modes (SH0).

COC: Chinese Oral Competition

Time: 10/4/2024 Fri 15:20-16:50

Judge: Jiunn-Woei Liaw, Jia-Hong Sun, Juin-Fu Chai

Time	Title		Author	Location
15:20-15:38	1028	高階模態群導波在流體負載下的傳遞行為探討	蔡官邑, 黃靖傑, 楊哲化	Nusantaria E 1F
15:38-15:56	1031	人工智慧於定量雷射超音波檢測缺陷定位之應用	葉祐良, 黃聖權, 楊哲化	
15:56-16:14	1048	敲擊回音法檢測植筋錨固之回歸曲線分析使用時機之探討	吳姵玟, 余志鵬	
16:14-16:32	1056	應用於非導磁金屬導電率估測之線圈阻抗渦電流感測方法	吳易秦, 藍宥麟, 林峻永	
16:32-16:50	1063	渦電流自動辨識技術	林佑儒	

Time: 10/4/2024 Fri 15:20-15:38

Location: Nusantaria E 1F

Paper Number: 1028

高階模態群導波在流體負載下的傳遞行為探討

蔡官邑 [1,*], 黃靖傑 [1], 楊哲化 [1]

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本研究提出利用高階模態群導波對油槽進行檢測，並使用 Abaqus 有限元素分軟體分析高階模態群導波於無流體與流體負載下的波傳行為與衰減效應，另外透過雷射可視化系統在油槽模型上進行實驗與有限元素分析結果進行對比，研究結果顯示高階模態群導波在經過有流體負載下的油槽時會發生洩漏，但由於高階模態群導波的特性，在經過一段距離的傳遞後模態更加穩定，導致位移能量集中於幾何形狀中間而減少表面位移洩漏於流體中。

Time: 10/4/2024 Fri 15:38-15:56
Location: Nusantaria E 1F
Paper Number: 1031

人工智慧於定量雷射超音波檢測缺陷定位之應用

葉祐良[1,*], 黃聖權[1], 楊哲化[2]
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在超音波檢測領域中，導波(Guided wave)技術為非破壞評估(Non-Destructive Evaluation, NDE)的重要檢測工具。然而，目前對於導波檢測技術在缺陷定位和辨識方面仍存在著挑戰。本研究旨在利用定量雷射超音波顯像系統(Quantitative Laser Ultrasound Visualization System, QLUV)與人工智慧(Artificial Intelligence, AI)技術結合，以提高缺陷檢測的準確性和效率。將人工智慧應用於QLUV系統生成的影像中，以辨識缺陷的存在與否、準確定位缺陷的位置以及識別缺陷的種類，並以此為目標訓練兩種不同的深度學習模型。結果顯示相較於傳統的人工檢測方法，本研究所開發 YOLONAS (You Only Look Once-Neural Architecture Search, YOLO-AS)模型之缺陷檢測技術，成功地提升定量雷射超音波顯像系統針對缺陷檢測之效率，藉由人工智慧的輔助省去人工逐一辨識之過程，也成功解決過去定量雷射超音波顯像系統在缺陷量測時精度不佳之問題，增加導波技術在受腐蝕之材料缺陷檢測上之可行性。

Time: 10/4/2024 Fri 15:56-16:14

Location: Nusantaria E 1F

Paper Number: 1048

敲擊回音法檢測植筋錨固之回歸曲線分析使用時機之探討

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本文目的開發一種量化方法，能夠在不需要在執行目標鋼筋的衝擊回波測試之前建立數學數據庫的情況下，有效評估種植鋼筋的嵌入狀況。並提供一個通用分析模型，直接將選擇的頻譜數據與任意鋼筋樣本或類似測試對象的黏結界面的有意義的物理參數聯繫起來。其中介紹以“主導頻率”方法能夠作為量化嵌入鋼筋錨固狀況的有用技術，該技術可行性依賴於在測試之前建立好的統計或回歸方程，本文通過新增環氧樹酯勁度對迴歸曲線係數進行延伸分析，發現在特定區段有不穩定的現象，限制該方法在實踐中的適用性，並針對回歸曲線分析的使用時機進行探討。

Time: 10/4/2024 Fri 16:14-16:32

Location: Nusantaria E 1F

Paper Number: 1056

應用於非導磁金屬導電率估測之線圈阻抗渦電流感測方法

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本論文提出用於測量雙層非導磁金屬板的導電率和厚度的渦電流感測器，以及量測單層非導磁薄金屬板的導電率感測器。透過量測於金屬板中感應渦電流影響激勵線圈的阻抗變化，間接計算金屬板的幾何特徵和物理性質。以擴展截斷區域特徵函數展開方法建立渦流的正向數學模型，以有限級數形式的解析解計算線圈阻抗，透過掃頻將量測值輸入，基於最小平方法及置信域方法設計的估測演算法，求得的最優化解即為金屬板各層的導電率和厚度的估測值，當金屬板厚度與集膚深度的比值足夠大時，可化簡數學式為只和待測金屬板導電率有關，用以量測單層薄金屬板的導電率。正向模型以有限元素軟體 COMSOL 驗證，並於實驗上使用阻抗分析儀的單頻以及掃頻分析，量測線圈於非導磁金屬板的阻抗變化，通過實驗上兩個已知導電率的金屬板，校正實驗與模型的誤差，透過掃頻達到雙層金屬板導電率和厚度的量測，以單頻解決商用金屬導電率量測儀不適用於薄金屬板量測的缺點。

Time: 10/4/2024 Fri 16:32-16:50

Location: Nusantaria E 1F

Paper Number: 1063

渦電流自動辨識技術

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本文闡述一項基於「卷積神經網路」的通用型自動化 AI 技術，專門用於渦電流訊號的分析與判斷。此技術能夠模擬人類專家的認知過程，迅速而準確地辨識渦電流檢測訊號。由於其核心架構是卷積神經網路，因此具備處理影像型和 數據型訊號的能力。當渦電流訊號發生變化時，這些變化會反映在特徵矩陣中。透過本技術所提出的特徵矩陣排列方式，每個瑕疵都能對應其特定的形態特徵，並且透過相似度擬合技術，能推測出渦電流訊號所代表的缺陷型態。該技術結合高級檢測師的判斷結果，並將這些結果標籤化，以訓練 AI 學習人類專家判斷特徵過程。此外，該技術利用渦電流檢測特性，提取包括頻率、探頭類型和混波等訊號

形式，來構建特徵矩陣。相比僅以振幅狀態評估訊號型態的方法，此方法具備更優越的辨識能力。報告還詳細描述該 AI 技術的應用，包括針對 Zetek 系統的影像式訊號辨識法，以及適用於 EddyFi 和 Olympus 系統的數據型訊號辨識法。最終，通過實際場域測試驗證，此技術展示其高效率和高精確度的優勢。

PC: Poster Competition

Time: 10/5/2024 Sat 13:00-14:36

Judge: Ju-Yi Lee, Peng-Chi Peng

Time	Title		Author	Location
13:00-13:12	1006(Ch)	離岸風電水下基礎超音波檢驗銲道根部訊號之研究	陳亭安	Nusantaria E 1F
13:12-13:24	1007(Ch)	離岸風電超音波檢測結合無人機內視鏡檢測之應用	洪裕翔	
13:24-13:36	1016(Ch)	音洩檢測技術應用於儲槽洩漏之初探	胡喻柏, 陳建曄, 盧信佑	
13:36-13:48	1033(Ch)	不銹鋼桶槽表面遠端目視影像資料庫與處理系統建置	張佐民, 董曉明	
13:48-14:00	1061(Ch)	電磁式超音波評估電廠管路薄化和材質劣化的創新與應用	林士瑄, 林宏儒, 黃鴻鈞, 吳志成, 蘇逸彥	
14:00-14:12	1086(Ch)	熱交換管裂縫之肇因與檢測探討	鍾明雄, 陳秀易, 葉嘉興	
14:12-14:24	1042(En)	Analysis of Debonding in Adhesive Bonded Structure using Quasistatic Components of Nonlinear Guided Waves: A Numerical Study	Yongjoon Choi, Mohammed Aslam, Jaesun Lee	
14:24-14:36	1087(En)	Comprehensive 360-Degree Automated Optical Inspection for Improved PCB Defect Detection	Chun-Lung Cheng, Jing-Feng Weng	

Time: 10/5/2024 Sat 13:00-13:12

Location: Nusantaria E 1F

Paper Number: 1006 (Chinese)

離岸風電水下基礎超音波檢驗銲道根部訊號之研究

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本文主要探討台灣離岸風力發電管架式結構的超音波檢驗技術（UT），針對根 部訊號的分析，以提升檢驗品質。隨著全球對氣候變遷的關注，台灣積極利用其地理優勢發展離岸風場，並廣泛應用管架式水下基礎。然而，這些結構的複雜性增加了超音波檢驗的挑戰。當前國內相關技術尚不成熟，導致檢驗人員因經驗不足而發生漏檢或誤檢，特別是在根部銲道的檢測中，由於板位差和銲道幾何形狀的影響，對缺陷的判定存在挑戰。本研究通過規範理論和實例測試，深入分析 UT 根部訊號的波型，並通過銲接順序的驗證，證實了改善銲接的順序能顯著提升銲接品質並減少缺陷的再發。總體來說，本文為提升 UT 檢驗準確性及改善銲接工藝提供了重要的技術參考，具有實質意義。

Time: 10/5/2024 Sat 13:12-13:24

Location: Nusantaria E 1F

Paper Number: 1007 (Chinese)

離岸風電超音波檢測結合無人機內視鏡檢測之應用

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本文主要探討超音波檢測法結合內視鏡檢測技術應用於離岸風電-管架式水下基礎 Jacket 其電纜管 J-tube。由於銲接參數設定不良、人員操作問題，容易造成電纜管 J-tube 管內對接銲道產生缺陷，如根部過度滲透、垂流及銳邊等。當海底電纜通過電纜管 J-tube 安裝時由於缺陷(如銳角 sharp edge)而導致破損風險。因此利用非破壞檢測搭配無人機內視鏡檢測技術，藉以發現缺陷位置並予以移除外，同時針對銲接製程作改善，以預防在海事工程安裝階段其電纜受損風險及後續龐大重工成本。

Time: 10/5/2024 Sat 13:24-13:36

Location: Nusantaria E 1F

Paper Number: 1016 (Chinese)

音洩檢測技術應用於儲槽洩漏之初探

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在石化產業中，儲存流體的儲槽扮演著相當重要的角色。在長時間的使用下，因大自然環境及人為等因素使儲槽結構強度衰減，造成儲槽底板腐蝕、破孔與洩漏等危害，使儲槽需開槽檢修造成人力及維修成本增加。為降低前述之成本，吾人採用音洩檢測技術(Acoustic Emission Detection Technique)對儲槽進行檢測，並針對洩漏檢測加以研究，探討音洩檢測技術應用於儲槽洩漏之可行性，而後透過實際開槽驗證檢測成果，以達事先縮小查漏範圍，節省成本之目的。

Time: 10/5/2024 Sat 13:36-13:48

Location: Nusantaria E 1F

Paper Number: 1033 (Chinese)

不銹鋼桶槽表面遠端目視影像資料庫與處理系統建置

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本研究建置一套可適用於檢測大型不銹鋼桶槽的遠端目視影像檢測處理系統，可以電腦遠端操作機台對桶槽表面進行自動化光學檢測，接之以自行開發之影像處理程式拼接桶槽表面影像、定位影像座標與進行資料庫檔案整理。

Time: 10/5/2024 Sat 13:48-14:00

Location: Nusantaria E 1F

Paper Number: 1061 (Chinese)

電磁式超音波評估電廠管路薄化和材質劣化的創新與應用

林士瑄 [1,*], 林宏儒 [1], 黃鴻鈞 [1], 吳志成 [1], 蘇逸彥 [1]

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本研究嘗試以電磁式超音波檢測技術取代傳統直束超音波檢測應用，研究結果顯示電磁式超音波不受表層粗糙及漆膜影響，同時保有傳統超音波高精度、高再現性等優點，並大幅降低檢測人員操作誤差。另可在鍋爐水牆管具表面銹層的條件下，進行厚度量測及材質劣化應用，協助電廠提前發現減薄及劣化熱區。整體而言，電磁式超音波在電廠管路薄化和壽命評估方面發揮極大的優勢，但對於非鐵磁性材質和長軸型試件，則仍無法取代傳統超音波檢測應用。

Time: 10/5/2024 Sat 14:00-14:12

Location: Nusantaria E 1F

Paper Number: 1086 (Chinese)

熱交換管裂縫之肇因與檢測探討

鍾明雄 [1,*], 陳秀易 [1], 葉嘉興 [1]

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熱交換器廣泛應用於發電、石油、化工等領域，是維持營運的重要組件，一旦破損將造成營運的重大延宕。熱交換器會發生腐蝕、沖蝕、磨耗、龜裂等各類瑕疵，其中龜裂屬於較為嚴重但常被忽略的缺陷，有些且不易檢出。本論文分析近年來各專家學者關於熱交換器管因龜裂而損壞的報告，歸納熱交換器發生各類型裂紋的原因，其訊號特性，以及檢測時裂紋沒被列入報告的問題，並提出檢測方案及應注意之要點。

Time: 10/5/2024 Sat 14:12-14:24
Location: Nusantaria E 1F
Paper Number: 1042 (English)

Analysis of Debonding in Adhesive Bonded Structure using Quasistatic Components of Nonlinear Guided Waves: A Numerical Study

Yongjoon Choi[1], Mohammed Aslam[2], Jaesun Lee[3,*]
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In the field of adhesive bonding, particularly in aerospace, automotive, and structural engineering, the detection and characterization of debonding present significant challenges. Traditional linear ultrasonic methods often fall short in identifying early-stage defects, such as micro-cracks and debonding, which can severely compromise structural integrity. This study explores the application of Quasi-Static Components (QSC) within nonlinear ultrasonic guided wave techniques to enhance the detection of such defects. Unlike conventional methods, QSC demonstrates superior sensitivity to micro-damage, leveraging the inherent material nonlinearity to detect subtle changes in the bonded structure. Through detailed simulations, we reveal that QSC can effectively identify debonding over

long distances with minimal signal attenuation, making it an ideal approach for early defect detection. The study further investigates the generation of higher harmonics as a result of contact acoustic nonlinearity (CAN), offering a robust framework for the non-destructive testing (NDT) of adhesive bonds. Our findings underscore the potential of nonlinear ultrasonic guided wave techniques, particularly QSC, in advancing the reliability and safety of bonded structures by providing a more sensitive and comprehensive assessment of structural health.

Time: 10/5/2024 Sat 14:24-14:36

Location: Nusantaria E 1F

Paper Number: 1087 (English)

Comprehensive 360-Degree Automated Optical Inspection for Improved PCB Defect Detection

Chun-Lung Cheng[1], Jing-Feng Weng[1,*]

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This study presents a novel Automated Optical Inspection (AOI) process for detecting defects in Printed Circuit Boards (PCBs) across a 360-degree range, addressing challenges such as random component placement, lighting variations, and lens distortion. The proposed method establishes an 8-angle (45-degree intervals) sample database as a reference for defect detection. High Dynamic Range (HDR) imaging is utilized to capture detailed, well-balanced images, mitigating lighting inconsistencies. The Scale-Invariant Feature Transform (SIFT) algorithm is used to match test samples with reference images by determining and correcting rotational angles. During the inspection phase, the reference samples are first cut into 20 blocks, after which the proposed enhanced-matching algorithm is applied to match the test samples. This algorithm effectively addresses lighting and contrast variations, ensuring robust detection. Testing on an Arduino PCB simulating common defects, such as poor soldering, detached components, and broken pins, demonstrates the superior robustness of the algorithm compared to traditional methods.

PS: Poster Session

Time: 10/5/2024 Sat 14:50-16:26

Chair: Po Ting Lin, Chieng Neng Wei

Time	Title		Author	Location
14:50-15:02	1009(Ch)	離岸風電 TYK 接頭非破壞檢測人才培訓推動紀實	黃柏焜, 顏嘉緯, 鄭偉凡	Nusantaria E 1F
15:02-15:14	1012(Ch)	磁漏檢測查驗技術精進	黃伯揚	
15:14-15:26	1043(Ch)	軋輥非破壞檢驗案例	張明弘, 蔡坤義	
15:26-15:38	1064(Ch)	使用疊紋干涉術測量旋轉角度	陳柏翰, 張智翔, 楊喆安, 許正治	
15:38-15:50	1067(Ch)	基於人工智慧的熱交換管缺陷渦電流檢測中支撐板干擾的濾波方法	鄧依庭, 陳鵬宇, 吳維勁, 古運承, 高永浩, 陳彥誠, 郭茂坤, 廖駿偉	
15:50-16:02	1068(Ch)	熱交換管圓周向裂縫訊號辨識技術提升	洪敬傑, 楊家銘	
16:02-16:14	1080(Ch)	單向纖維複合材料裂縫試驗	吳定恩, 江支弘	
16:14-16:26	1079(En)	Modelling a Deep Ultraviolet Light Emitting Diode with a Cubic-Boron-Nitride Electron Blocking Layer	Wen-Chi Liu, An-Chi Wei	

Time: 10/5/2024 Sat 14:50-15:02

Location: Nusantaria E 1F

Paper Number: 1009 (Chinese)

離岸風電 TYK 接頭非破壞檢測人才培訓推動紀實

黃柏焜 [1], 顏嘉緯 [1], 鄭偉凡 [1]

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非破壞檢測產業為離岸風電產業之品質檢驗中重要的一環，但國內從業人員投入其中之比例卻略顯不足，雖國內取得 ISO 9712 NDT 資格非破壞檢測從業人員雖陸續增加，但對於執行水下基礎之 Jacket 管狀 TYK 接頭品質之超音波檢驗的技術能力與紀經驗仍處啟蒙階段，且其採用的規範皆為 ISO 規範雖與國內常態採用的規範雖大同小異，但仍受到外國風電系統開發商質疑，綜觀上述，國內急需針對特殊銲接接頭型式的檢測技術的推廣，此想法源自於興達海基 董寶鴻助理副總經理。經過幾次溝通確認可行的執行方式，由金屬中心提案，於 112 年正式成為經濟部產業發展署所推動的離岸風電產業輔導與零碳技術推動計畫中的一個分項計畫:離岸風電產業非破壞檢測人才培訓，本篇論文綜整執行計畫的重要關鍵與執行秘辛，希望能透過本論文讓特殊銲接接頭的非破壞檢測技術培訓課程獲得更有效的推廣，進而提升整個產業發展。

Time: 10/5/2024 Sat 15:02-15:14

Location: Nusantaria E 1F

Paper Number: 1012 (Chinese)

磁漏檢測查驗技術精進

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以鋼索磁漏檢測技術作業，包括檢測計劃、靈敏度設定及設備查驗，以探討檢測設定及比對基準值，驗證鋼索磁漏檢測技術有效檢出鋼索截面積損耗，評估鋼索使用情況，協助現場單位維護檢修重要設備，並將成果應用於精進查驗技術及查驗規塊開發：1. 精進查驗技術，利用各個測試試片搭配，交叉比較訊號振幅相對變化，辨識截面積損耗程度，驗證最適宜靈敏度上下限設定值，依應用結果建立鋼索磁漏檢測資料庫，精進查驗技術。2. 查驗規塊開發，依鋼索磁漏檢測資料庫，建立查驗規塊組之截面積與材質資訊，以鋼管、棒鋼型式規塊，再依待測物金屬截面積配合調整之形式，可製作模擬各鋼索截面積之查驗規塊。

Time: 10/5/2024 Sat 15:14-15:26

Location: Nusantaria E 1F

Paper Number: 1043 (Chinese)

軋輥非破壞檢驗案例

張明弘 [1,*], 蔡坤義 [1]

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本文探討了非破壞檢測（NDT）在扁鋼胚軋延過程中對軋輥品質管理和問題解決的案例:(1)NDT 技術協助分析軋輥的斷裂原因，發現斷輥源自於輥頸處銲補裂紋，屬於製造缺陷，藉此向原廠提出訴賠、(2)依採購規範把關新採購軋輥品質，針對異常軋輥向原廠訴賠，以及把關軋輥下線研磨品質，避免上線使用後斷輥影響生產效率、(3)改善檢測技術，使用表面波取代傳統的磁粉檢測，提升檢測效率，同時顯著降低了檢測費用並減少了人員的勞動強度。這些成果顯示了 NDT 技術在確保生產穩定性和提高品質管理方面的重要性。

Time: 10/5/2024 Sat 15:26-15:38

Location: Nusantaria E 1F

Paper Number: 1064 (Chinese)

使用疊紋干涉術測量旋轉角度

陳柏翰 [1], 張智翔 [1], 楊喆安 [1], 許正治 [1,*]

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在本研究中，旋轉角度可以使用疊紋干涉術來確定，通過分析莫爾紋圖樣的物理量可以回推旋轉角度。根據實驗結果，所提出的方法達到了優於 4°/(lp/cm)的旋轉角度靈敏度。

Time: 10/5/2024 Sat 15:38-15:50

Location: Nusantaria E 1F

Paper Number: 1067 (Chinese)

基於人工智慧的熱交換管缺陷渦電流檢測中支撐板干擾的濾波方法

鄧依庭 [1], 陳鵬宇 [1], 吳維勁 [2], 古運承 [1,2], 高永浩 [1], 陳彥誠 [2], 郭茂坤 [1], 廖駿偉 [2,3,*]

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本研究利用基於人工神經網路(ANN)的濾波器，對鈦標準管的四頻渦電流檢測數據進行處理，以消除支撐板對各種缺陷信號的非線性干擾，從而保留純粹的缺陷信號，以保留更可靠的特徵供後續缺陷分析使用。特別地，AI學習時考慮了各種缺陷與支撐板之間的相對距離對信號的影響。結果顯示，該基於 ANN 的濾波器能有效去除支撐干擾，在不扭曲各種缺陷信號特徵的情況下，隔離出純粹的缺陷信號，從而促進後續的缺陷檢測與分析。

Time: 10/5/2024 Sat 15:50-16:02

Location: Nusantaria E 1F

Paper Number: 1068 (Chinese)

熱交換管圓周向裂縫訊號辨識技術提升

洪敬傑 [1,*], 楊家銘 [1]

[1] 中國公司智財與檢測技術處非破壞檢驗課

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熱交換器設備為汽電共生發電機組之重要關鍵設備，定期以渦電流技術檢查可有效降低設備因破管而緊急停機無法發電之成本。某機組熱交換管發生圓周向破損裂縫，其裂縫型態特徵長度短且呈現圓周向分布，剛好位於傳統式熱交換管渦電流探頭之檢測盲區中，因而無法可靠有效被檢出。本文藉由重新檢視自製探頭之產製流程降低潛在之誤差來源，輔以人工瑕疵探討傳統式內繞式線圈對裂縫訊號之檢測極限，同時嘗試改良線圈設計並成功提升缺陷訊號之振福與相位角滯後特性，表現優異。後續將持續對探頭外部結構強化其設計並推行於現行設備定期檢查中。

Time: 10/5/2024 Sat 16:02-16:14

Location: Nusantaria E 1F

Paper Number: 1080 (Chinese)

單向纖維複合材料裂縫試驗

吳定恩 [1,*], 江支弘 [1]

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易脫層(delamination)是許多先進層狀複合材料結構的主要設計問題之一。透過試驗步驟和數據分析，探討複合材料層板對層間斷裂的抵抗力，有助於了解材料在 I 型斷裂模式破壞下的機械性能，有助於產品開發和材料選擇。我們根據 ASTM D5528 標準描述的試驗方法，測試複合材料的層間斷裂韌性（Interlaminar fracture toughness），特別是針對第 I 型斷裂模式（Mode I fracture toughness）的測試。本文以單向碳纖維預浸布，製作的雙懸臂梁（Double Cantilever Beam，DCB）試件，由試驗結果中提取的關鍵數據，計算層間斷裂韌性，繪製抗脫層性能曲線(Delamination resistance curve)， 將有助於評估層狀複合材料抵抗脫層的機械性能。

Time: 10/5/2024 Sat 16:14-16:26
Location: Nusantaria E 1F
Paper Number: 1079 (English)

Modelling a Deep Ultraviolet Light Emitting Diode with a Cubic-Boron-Nitride Electron Blocking Layer

Wen-Chi Liu[1], An-Chi Wei[1,2,*]

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[2]Graduate Institute of Energy Engineering, National Central University

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We report the modelling on the energy band diagram of a deep ultraviolet (DUV) light-emitting diode (LED), which includes the cubic boron nitride (c-BN) as the electronblocking layer (EBL). Because of the wide band gap and the high thermal conductivity of the c-BN, the EBL is suitable to be operated in DUV range and has better thermal stability. In the future, optimizing the layer structure and the device processing procedures may further enhance the performance of these DUV-LEDs, realizing highly efficient nitride devices.

SS1: Infrared Thermography

Time: 10/4/2024 Fri 15:20-17:08

Chair: Chih-Hung Chiang

Time	Title		Author	Location
15:20-15:56	Keynote	Development of NDT & E Techniques for Long-Span Steel Bridges Based on Multi-Wavelength Infrared Measurements	Takahide Sakagami, Daiki Shiozawa	Nusantaria A 1F
15:56-16:14	1021	Thermal Imaging of Thin CFRP Plates Subjected to Cyclic Loading	Chih-Hung Chiang, Yung-Chiang Lin, Yishuo Huang, Mahesh	
16:14-16:32	1022	Building Detect Detection by Analyzing Thermography with Intensity Inhomogeneity	Yishuo Huang, Jian-Jia Hong	
16:32-16:50	1030	Fatigue Crack Detection by Low Power Laser Thermography	Yuya Murao, Daiki Shiozawa, Takahide Sakagami	
16:50-17:08	1065	Building Health Monitoring with Applying Different Infrared Thermal Cameras by Analyzing Thermography	Yishuo Huang, Pin-Hsuan Kuo,	

Time: 10/4/2024 Fri 15:20-15:56

Location: Nusantaria A 1F

Keynote

Development of NDT & E Techniques for Long-Span Steel Bridges Based on Multi-Wavelength Infrared Measurements

Takahide Sakagami*, Daiki Shiozawa

Department of Mechanical Engineering, Kobe University, Japan

*Corresponding Author: sakagami@mech.kobe-u.ac.jp

Predictive maintenance and condition-based maintenance are becoming more important to ensure the safety of aging infrastructures. Infrared imaging is useful for efficient inspection of a wide range of

structures. A nondestructive testing technique using thermal infrared temperature measurement was developed to detect fatigue cracks in large steel structures based on the temperature distribution anomaly, appearing at fatigue cracks due to the thermal insulation effect. Further nondestructive evaluation methods were developed for fatigue cracks to evaluate the structural integrity. On-site stress distribution measurements were conducted by the thermoelastic stress analyses under actual loading conditions. The fracture mechanics approach was adopted for measured stress distribution data to evaluate structural integrity. In addition, nondestructive testing techniques that utilize transmission / absorption characteristics of infrared light in a specific wavelength range were developed. A remote noncontact monitoring technique was developed using a short wavelength infrared camera for early deterioration detection of anticorrosion paint coating employed for steel bridges. This presentation will introduce some application results from the above-mentioned techniques.

Time: 10/4/2024 Fri 15:56-16:14

Location: Nusantaria A 1F

Paper Number: 1021

Thermal Imaging of Thin CFRP Plates Subjected to Cyclic Loading

Chih-Hung Chiang[1,2,*], Yung-Chiang Lin[2], Yishuo Huang[2], Mahesh[1]

[1]Graduate Institute of Aeronautics, Chaoyang University of Technology

[2]Department of Civil and Construction Engineering, Chaoyang University of Technology

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One challenge associated with using thin CFRP components is the potential for defects during fabrication, which could raise concerns about structural integrity. This can be an important quality issue for composite structural components subject to cyclic loading. Current study applies passive thermography to defect analysis of thin CFRP plates. A smallscale testing system is developed for applying cyclic loading to the CFRP specimens. Thermal image sequences captured are processed by Robust Principal Component Analysis. The initial results show features that are not visible in the original thermal images.

Time: 10/4/2024 Fri 16:14-16:32
Location: Nusantaria A 1F
Paper Number: 1022

Building Detect Detection by Analyzing Thermography with Intensity Inhomogeneity

Yishuo Huang[1,*], Jian-Jia Hong[1]
[1]Department of Civil and Construction Engineering, Chaoyang University of Technology
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Thermography has widely been employed to monitor the health conditions of buildings. The thermal patterns of defects illustrated in a building have fully developed after heating by solar energy. Those developed patterns can be identified by applying image segmentation. Image segmentation can segment thermography into several segmented regions, and those segmented regions can be the clues to identify defects. Image segmentation can be affected by intensity inhomogeneity. Intensity inhomogeneity indicates the pixels in thermography containing surface temperature information and extra information, like glares and refractions. The paper proposed the approach to model intensity inhomogeneity into a linear model presented by Taylor's expansion. An iteration scheme is proposed to segment the thermography and approximate intensity inhomogeneity by introducing two level-set functions. The proposed approach was applied to the infrared thermal camera installed on an uncrewed aerial vehicle (UAV) and the infrared thermal camera, NEC Pro 500, installed on the ground. The processed results demonstrate that the proposed approach can be used for building health monitoring.

Time: 10/4/2024 Fri 16:32-16:50

Location: Nusantaria A 1F

Paper Number: 1030

Fatigue Crack Detection by Low Power Laser Thermography

Yuya Murao[1], Daiki Shiozawa[1,*], Takahide Sakagami[1]

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For maintenance management of steel structures, it is important to detect fatigue cracks early and non-destructively. This study focused on the active thermography method, which uses laser heating, as a non-destructive inspection method for fatigue cracks. Fatigue cracks are detected by remotely irradiating a laser near the crack and capturing the characteristic changes in temperature distribution that occur near the crack. In this study, a spot-shaped laser with low power was used. A method was developed to detect the overall shape of crack by calculating a differential temperature image from multiple infrared images obtained by scanning spot laser measurement.

Time: 10/4/2024 Fri 16:50-17:08

Location: Nusantaria A 1F

Paper Number: 1065

Building Health Monitoring with Applying Different Infrared Thermal Cameras by Analyzing Thermography

Yishuo Huang[1,*], Pin-Hsuan Kuo[1]

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[*]Corresponding Author: yishuo@cyut.edu.tw

Thermography has widely been employed to monitor the health conditions of buildings. The thermal patterns of defects illustrated in a building have fully developed after heating by solar energy. Those developed patterns can be identified by applying image segmentation. Image segmentation can segment thermography into several segmented regions, and those segmented regions can be the clues to identify defects. Image segmentation can be affected by intensity inhomogeneity. Intensity inhomogeneity indicates the pixels in thermography containing surface temperature information and extra information, like glares and refractions. The paper proposed the approach to model intensity inhomogeneity into a linear model presented by Taylor's expansion. An iteration scheme is proposed to segment the thermography and approximate intensity inhomogeneity by introducing two level-set functions. The proposed approach was applied to the infrared thermal camera installed on an uncrewed aerial vehicle (UAV) and the infrared thermal camera, NEC Pro 500, installed on the ground. The processed results demonstrate that the proposed approach can be used for building health monitoring.

SS2: Smart Materials for Sensing and Related Applications / SS5: Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves

Time: 10/4/2024 Fri 15:20-16:50

Chair: Po Ting Lin

Time	Title		Author	Location
15:20-15:56	Keynote	Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves (Paper No: 1024)	Speaker: Jaesun Lee Author: Boris I, Mohammed Aslam, Jaesun Lee	Nusantaria D 1F
15:56-16:14	1049	Study on membrane tensile force of photomask protective membrane for quality evaluation	Yu-Ching Lee, Yuan-Wen Chen	
16:14-16:32	1076	Internal Pipe Defect Inspection Based on Fusion of PVDF/Graphene Piezoelectric Sensor and Magnetic Induction Sensor with Machine Learning	Edmun Iro Kavalo Halawa, Brijesh Patel, Yao-Chung Hsu, Lung-Jenq Wu, Wei-Song Hung, Po Ting Lin	
16:32-16:50	1078	Model Based Fault Detection and Identification of Induction Motors Using Single-Phase Measurements	Dhewangga Pratama, Chen-Yang Lan, Kenny Fuh,	

Time: 10/4/2024 Fri 15:20-15:56

Location: Nusantaria D 1F

Keynote (Paper Number: 1024)

Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves

Boris I[1], Mohammed Aslam[2], Jaesun Lee[3,*]
[1]Department of smart manufacturing, Changwon National University, Rep. of Korea
[2]Extreme Environment Design and Manufacturing Engineering Innovation Centre, Changwon National University, Rep. of Korea
[3]School of mechanical engineering, Changwon National University, Rep. of Korea
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The study and application of metamaterials for elastic guided waves have opened new perspectives across various fields, significantly advancing both theoretical and practical aspects of wave manipulation. Recent research on phononic crystal-based meta-structures for linear and nonlinear guided waves has yielded promising results, capturing the attention of both academia and industry. Our investigation, as discussed in this paper, focuses on optimizing phononic crystal (PC) designs using a numerical approach that considers temperature effects, thereby making them viable as differential temperature sensors. Additionally, another study explores vibration isolation for tube structures, highlighting the effectiveness of phononic crystals in such applications. The paper also discusses the application of meta-structures for improving nonlinear-based ultrasonic testing, which enhances the isolation of system harmonics to increase sensitivity in damage detection.

Time: 10/4/2024 Fri 15:56-16:14
Location: Nusantaria D 1F
Paper Number: 1049

Study on membrane tensile force of photomask protective membrane for quality evaluation

Yu-Ching Lee[1,*], Yuan-Wen Chen[1]
[1]Department of Mechanical Engineering, National Taiwan University of Science and Technology
[*]Corresponding Author: yclee@mail.ntust.edu.tw

Photomasks are crucial in the lithography process for semiconductor manufacturing. The photomask protective membranes used to prevent the photomask from defect pollution are highly sensitive to external disturbances that can occur during production, mounting, and handling, which may lead to deterioration. This study investigates a method to accurately calculate the tensile force of photomask

protective membrane, including simulation and experiment. A simulation model is developed using the assumption of large deformation, and its results with the vibration frequencies are compared with experimental measurements to inversely calculate the membrane tensile force. In this experiment, a laser displacement sensor is employed to measure the out-of-plane displacement of the membranes when subjected to external disturbances. Subsequently, the vibration frequency of the membranes is determined by applying a fast Fourier transform to the data. Furthermore, the simulation model is used to evaluate how changes in the membrane tensile force by cyclic test of the protective membrane specimens. The goal of this research is to reduce the need for frequent replacements on protective membrane, potentially enhancing wafer yield.

Time: 10/4/2024 Fri 16:14-16:32

Location: Nusantaria D 1F

Paper Number: 1076

Internal Pipe Defect Inspection Based on Fusion of PVDF/Graphene Piezoelectric Sensor and Magnetic Induction Sensor with Machine Learning

Edmun Iro Kavalo Halawa[1], Brijesh Patel[1], Yao-Chung Hsu[1], Lung-Jenq Wu[2], Wei-Song Hung[3], Po Ting Lin[1,4,5,*]

[1]Department of Mechanical Engineering, National Taiwan University of Science and Technology

[2]Material and Chemical Research Laboratories, Industrial Technology Research Institute

[3]Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology

[4]Intelligent Manufacturing Innovation Center, National Taiwan University of Science and Technology

[5]High-Speed 3D Printing Research Center, National Taiwan University of Science and Technology

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Internal pipeline inspection often employs Non-Destructive Testing (NDT) methods. Piezoelectric materials, which generate signals from physical contact, are wellsuited for NDT applications and can effectively detect defects within pipes. This study presents an elliptical wheel-shaped piezoelectric sensor design to sense the internal pipe defects when integrated with a Pipeline Inspection Gauge (PIG). The wheel sensor features a sandwich structure with a middle layer composed of a PVDF/Graphene membrane, coated with Polydimethylsiloxane (PDMS) on both sides. To address the issue of cable twisting during wheel rotation, electromagnetic induction is utilized for continuous signal transfer. The data collected from the sensor's contact with the internal pipe surface will be analyzed using Machine Learning techniques, including Support Vector Machine (SVM), Random Forest, and K-nearest neighbors (KNN). Among these methods, the sensor achieved its best performance using a Support Vector Machine (SVM), with F1 score of 71.25%.

Time: 10/4/2024 Fri 16:32-16:50

Location: Nusantaria D 1F

Paper Number: 1078

Model Based Fault Detection and Identification of Induction Motors Using Single-Phase Measurements

Dhewangga Pratama[1], Chen-Yang Lan[1,*], Kenny Fuh[2]

[1]Department of Mechanical Engineering, National Taiwan University of Science and Technology

[2]Jhunan Facility Engineering Division Group, Innolux Corporation

[*]Corresponding Author: jimmylan@mail.ntust.edu.tw

Fault detection and Identification (FDI) for induction motors (IM) condition monitoring typically involves on detecting developing faults from measured data by comparing them to normal conditions. Effective FDI methods are crucial for maintaining motor and its driven system's reliability and performance. This paper introduces a fault diagnosis method for three-phase IM which utilizes single-phase measurements and estimation to detect and identify faults under quasi-steady-state conditions. The proposed method employs a system identification approach with a single-input single-output

(SISO) state-space model and utilizes the Numerical Algorithms for Subspace State Space System Identification (N4SID) parameter estimation algorithm. FDI are performed by comparing the residual current between healthy and faulty conditions. The approach was tested with belt breakage and bearing faults using only half of the available data, which implies fewer measurement points. As an initial effort in monitoring a scrubber fan driven by an IM, the results show a promising approach for effective FDI with reduced models and measurements. The study hence demonstrates that the single-phase FDI approach is effective and feasible for practical applications.

SS3: Optical Metrology

Time: 10/4/2024 Fri 13:30-15:00

Chair: Ju-Yi Lee

Time	Title		Author	Location
13:30-13:48	1017	Development of an Automated Measurement System for Sapphire Glass Holes Based on Shape from Focus Method	Yan-Rui Lin, Chun-Yen Chu, Ju-Yi Lee	Nusantaria A 1F
13:48-14:06	1023	One-Shot Polarization Interferometry for Surface Profile Measurement	Hsing-Hsien Tsai, Yue-Jhe Tsai, Ju-Yi Lee, Ting-Hao Cao	
14:06-14:24	1027	Polarization Interferometry for High-Sensitivity Roll Angular Displacement Measurement	Wun-Yan Chen, Han-Hao Tseng, Ju-Yi Lee	
14:24-14:42	1037	Roll and Pitch Angular Displacements Measurement Based on Dual Beam Polarization Interferometry	Shu-Han Chang, Kuan-Yu Hsu, Ju-Yi Lee	
14:42-15:00	1044	Design of an optical-mechanical depth sensing system	Yao-Yuan Chang, Siao-Yu Chang Jian, Jing-Heng Chen, Kun-Huang Chen	

Time: 10/4/2024 Fri 13:30-13:48

Location: Nusantaria A 1F

Paper Number: 1017

Development of an Automated Measurement System for Sapphire Glass Holes Based on Shape from Focus Method

Yan-Rui Lin[1], Chun-Yen Chu[1], Ju-Yi Lee[1,*]

[1]Department of Mechanical Engineering, National Central University

[*]Corresponding Author: juyilee@ncu.edu.tw

This research developed an automated positioning and measurement system for circular holes based on the Shape from Focus technique, aimed at solving the precise alignment and fully automated

measurement problems of circular holes in sapphire glass. The system includes both hardware (such as CCD camera, various lenses, lighting devices, and electrically controlled displacement platform) and software (using Python and C++) components. The workflow is divided into coarse and fine automated positioning of circular holes and three-dimensional shape reconstruction. By comparing various focus value algorithms, the Scharr algorithm was found to be the most effective, with the smallest error compared to commercial equipment. System performance verification shows that under a 20x objective lens, the measurement range is 425 μm * 355 μm, with lateral and longitudinal resolutions of 0.871 μm and 0.8 μm respectively.

Time: 10/4/2024 Fri 13:48-14:06

Location: Nusantaria A 1F

Paper Number: 1023

One-Shot Polarization Interferometry for Surface Profile Measurement

Hsing-Hsien Tsai[1], Yue-Jhe Tsai[1], Ju-Yi Lee[1,*], Ting-Hao Cao[1]

[1]Department of Mechanical Engineering, National Central University

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This paper introduces an innovative instantaneous polarization interferometry technique that enables instantaneous nanoscale surface profile measurements over a wide measurement area. The optical setup is based on a Fizeautype interferometer and includes basic components such as a polymer retardation film, a quarter-wave plate, and a polarizing camera. Using the principle of polarization interference and using a polarization camera to capture images at one time, a four-phase orthogonal polarization interference image can be obtained. The surface profile can then be derived using a phase-shifting method based on these four-phase orthogonal polarization interference images. The proposed technique can simultaneously capture images of four polarization states to measure surface profiles without the need for complex mechanical structures or modulation controllers. The surface profile measurement resolution was experimentally demonstrated to be 11 nm.

Time: 10/4/2024 Fri 14:06-14:24

Location: Nusantaria A 1F

Paper Number: 1027

Polarization Interferometry for High-Sensitivity Roll Angular Displacement Measurement

Wun-Yan Chen[1], Han-Hao Tseng[1], Ju-Yi Lee[1,*]

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This study proposes a method for roll angular displacement measurement based on polarization interferometry. The technique utilizes the birefringence effect and polarization interferometry, combined with a polarization camera for phase detection, and employs a dual-beam configuration to effectively eliminate disturbances caused by variations in the incident angle, enabling precise measurement of roll angular displacement. Experimental results demonstrate that the dual-beam configuration significantly reduces the interference of pitch angular displacement on the roll angular displacement measurement system, allowing for accurate measurement of roll angles as small as 0.002°.

Time: 10/4/2024 Fri 14:24-14:42

Location: Nusantaria A 1F

Paper Number: 1037

Roll and Pitch Angular Displacements Measurement Based on Dual Beam Polarization Interferometry

Shu-Han Chang[1], Kuan-Yu Hsu[1], Ju-Yi Lee[1,*]

[1]Department of Mechanical Engineering, National Central University

[*]Corresponding Author: juyilee@ncu.edu.tw

This study proposes a method for simultaneous measurement of roll and pitch angular displacements based on polarization interferometry. This technique employs birefringent crystals as the measuring element and uses a polarization camera to analyze the phase differences variation induced by the crystal's angular isplacement. We have developed a dedicated polarization interferometer and phase analysis technique, capable of accurately measuring phase differences variations to determine roll and pitch angular displacements. This method surpasses the limited measurement range of traditional interferometers, achieving simultaneous measurement of roll and pitch angles within a 6- degree range. Upon uncertainty evaluation, the system has achieved a roll angle resolution of 2.5 arcseconds and a pitch angle resolution of 21.6 arcseconds.

Time: 10/4/2024 Fri 14:42-15:00

Location: Nusantaria A 1F

Paper Number: 1044

Design of an optical-mechanical depth sensing system

Yao-Yuan Chang[1], Siao-Yu Chang Jian[1], Jing-Heng Chen[2], Kun-Huang Chen[1,*]

[1]Department of Electrical Engineering, Feng Chia University
[2]Department of Photonics, Feng Chia University

[*]Corresponding Author: chenkh@fcu.edu.tw

This paper presents an optical-mechanical system for depth sensing. The system employs a negative micro-lens array to reduce the depth of field and capture 2D images. It scans a region by analyzing the relationship between focus distance and motor steps. Depth information is then obtained by assessing whether objects are in focus based on the sharpness of their outlines, along with the corresponding motor steps when the object is in focus. The system has been experimentally validated, demonstrating ease of use, minimal susceptibility to external factors, and compatibility with various mobile phone lenses.

SS4: Guided Waves

Time: 10/5/2024 Sat 13:00-14:30

Chair: Ping Hung Lee

Time	Title		Author	Location
13:00-13:36	Keynote	Optimised detection and sizing of pipe corrosion at supports using guided wave technology (Paper No: 1075)	Speaker: Chien An Chua Author: Chien An Chua, Andrew Zhi Jie Lee, Tomasz Pialucha	Nusantaria B 1F
13:36-13:54	1071	Guided Wave Inspection-Wherever the Pipeline Goes, Inspectors Follow	Ping Hung Lee et al.	
13:54-14:12	1074	Beyond Toys-The New Application of LEGO in Electromagnetic Ultrasonic Autonomous Vehicles	Ping Hung Lee et al.	
14:12-14:30	1084	Finite Distance Guided Wave Detection of Rail Defects with Directional Decomposition	Ching-Chung Yin, Tian-Can Feng, Shi-Yi Jhang	

Time: 10/5/2024 Sat 13:00-13:36

Location: Nusantaria B 1F

Keynote (Paper Number: 1075)

Optimised detection and sizing of pipe corrosion at supports using guided wave technology

Chien An Chua*, Andrew Zhi Jie Lee, Tomasz Pialucha

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Corrosion under pipe supports (CUPS) represents one of the most prevalent pipe defects encountered across oil, gas, and petrochemical facilities, posing serious risks of pipeline structural failure and ultimately product containment loss. Despite being external in nature, locating CUPS remains a formidable task due to the sheer number of pipe supports per pipeline, often numbering in the

hundreds. Conducting visual testing for each support proves impractical, particularly when pipes are elevated on racks or insulated. This paper introduces an optimized methodology for CUPS detection and sizing. This approach integrates a broadband guided wave screening technique which complies to ASTM E2775-16, ensuring reliable detection of CUPS over extensive pipe lengths. Additionally, an accurate guided wave scanning technique is employed for precise quantification of the remaining pipe wall thickness at corrosion sites.The efficacy of this method is demonstrated through inspection results obtained from an 8-inch pipeline situated on a pipe rack within a petrochemical complex, identified as a critical asset by its owner. These results showcase the early detection of several CUPS defects and provide insights into the extent of damage in terms of remaining pipe wall thickness. Through the synergistic utilization of guided wave screening and scanning techniques, this methodology offers a robust solution for enhancing CUPS detection and facilitating proactive maintenance strategies within industrial facilities.

Time: 10/5/2024 Sat 13:36-13:54

Location: Nusantaria B 1F

Paper Number: 1071

Guided Wave Inspection-Wherever the Pipeline Goes, Inspectors Follow

李秉鴻 [1,*], 朱民宏 [1], 洪鍏 [1], 佘國禎 [1]

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管線檢測或檢查在國內自從 10 年前高雄地下管線氣爆後便越來越受重視，超音波測厚(UT Gauging)、管內智能豬檢測(ILI)以及導波檢測技術(Guided Wave Testing)也都被廣為應用。作為專注於導波檢測應用的團隊，於本文中分享多種管線檢測應用領域的經驗，除了煉製與石化工業管線、鍋爐管線、鋼鐵廠管線、消防管線也包含了多種行業天然氣管線的檢測，管線所在位置可能在田野邊、可能在電子廠、可能在發電廠、可能在大樓停車場、也可能在公路橋梁附近。非破壞檢測是個有趣的行業，能藉由檢測工作機會接觸到台灣內各個領域的人、事、物，但也肩負了確保管線安全使用， 降低社會大眾使用管線的風險。

Time: 10/5/2024 Sat 13:54-14:12

Location: Nusantaria B 1F

Paper Number: 1074 (to be presented in English)

Beyond Toys-The New Application of LEGO in Electromagnetic Ultrasonic Autonomous Vehicles

李秉鴻 [1,*], 佘國禎 [1], 佘文喆 [2]

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於 2018 年由於儲槽漏油事件使得大家對於儲槽底板檢測的完整性需求提高，我們也在當年將定量電磁超音波檢測技術應用在儲槽支撐柱下方底板腐蝕(TBPUSI)的檢測，解決此部位無法檢測之問題。該檢測技術需檢測員穩定操作掃描器以取得再現性高且訊雜比好的底板訊號，最近在考慮現場作業環境許可下我們採用具有程式編輯的樂高玩具，將電磁超音波產生導波用的線圈安裝在設計好的自走車，形成可以一鍵完成掃描作業的系統，包括馬達驅動、固定線圈裝置、輪胎、自走車作動程式編輯等，成功地讓在家裡客廳玩耍用的樂高轉型成儲槽內非破壞檢測設備，協助檢測員取得最佳電磁超音波底板腐蝕訊號。

Time: 10/5/2024 Sat 14:12-14:30

Location: Nusantaria B 1F

Paper Number: 1084

Finite Distance Guided Wave Detection of Rail Defects with Directional Decomposition

Ching-Chung Yin[1,*], Tian-Can Feng[1], Shi-Yi Jhang[1]

[1]Department of Mechanical Engineering, National Yang Ming Chiao Tung University

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This study conducts finite element analysis to explore the feasibility of detecting rail defects within a limited range, demonstrating the potential of a 100 kHz guided wave rail inspection pod mounted on a train. The pod is equipped with a non-contact EMAT transmitter and an array of multiple EMAT sensors arranged in a pitch-catch configuration, specifically designed to identify defects in the forward region of the rail track. The transmitted guided waves frequently mask the small backscatter waves caused by defects. By applying directional decomposition, valuable insights are gained into the intricate process of backscatter waves generated by rail defects. The numerical and experimental results include animations illustrating the backscattering of guided waves from both transverse and horizontal defects in rail tracks.

SS5-C: Multi-functional Phononic Crystal-based Meta-structures for Linear and Nonlinear Guided Waves (Chinese)

Time: 10/5/2024 Sat 14:50-16:20

Chair: Jia-Hong Sun

Time	Title		Author	Location
14:50-15:08	1025	應用於縱波超音波換能器之聲子晶體波導研究	孫嘉宏, 周澄複, 陳永裕	Nusantaria B 1F
15:08-15:26	1051	防塵組件薄膜於氣壓差負載下擴張現象之研究	蔡煌龍, 李雨青, 林克默	
15:26-15:44	1069	以拓樸最佳化法設計二維寬能隙聲子晶體	鄭博文, 張湘淇, 張怡玲	
15:44-16:02	1085	應用卷積神經網路辨識鐵軌背向散射導波譜圖	張育瑞, 林意宸, 尹慶中	
16:02-16:20	1088	超音波流量計之高溫波導研究	陳泓銘, 尹慶中, 褚柏胤, 曾科穎	

Time: 10/5/2024 Sat 14:50-15:08

Location: Nusantaria B 1F

Paper Number: 1025

應用於縱波超音波換能器之聲子晶體波導研究

孫嘉宏 [1,*], 周澄複 [2], 陳永裕 [2]

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本文研究以聲子晶體為超音波波導之應用。透過應用波傳自對準特性，聲子晶體波導可抑制在內部傳遞之縱波轉換成導波模態，能延長聲波的傳遞距離且降低量測時的干擾，可應用於無法直接靠近待測物的非破壞檢測上。研究中利用有限元素法分析分析各種結構之二維聲子晶體的頻散曲線與波慢曲線，再將結果延伸至板波模態，設計出具自對準特性之聲子晶體。

而後進行聲子晶體波導設計，分析波導長度對於穿射率的影響，並加入匹配層提升穿射率與使用頻率範圍，以設計出具自對準特性之超聲波波導。結果顯示所設計之超聲波波導確實能將聲波能量集中在相應的角度，具有自對準效果，也驗證了聲子晶體結構之超聲波波導未來可被應用於工業用非破壞檢測上。

Time: 10/5/2024 Sat 15:08-15:26

Location: Nusantaria B 1F

Paper Number: 1051

防塵組件薄膜於氣壓差負載下擴張現象之研究

蔡煌龍 [1], 李雨青 [2,*], 林克默 [1]

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晶片製造是透過半導體微影製程將光罩上的電路圖形縮小轉印至晶圓上[1,2],光罩保護膜是用於微影製程中重要的防塵組件，由一層懸浮式薄膜與鋁框貼合而成[3]，當粉塵掉落薄膜表面時因遠離光線焦點可避免粉塵隨圖形轉印至晶圓。然而保護膜在曝光環境中受到壓力差而產生擴張行為將導致曝光後圖形產生扭曲，因此本研究提出了保護膜壓力差控制模組應用於薄膜最大擴張量預測。分析系統透過反射式條紋法結合四步相位移技術量測在受氣壓差負載下薄膜的三維形貌高度。實驗結果顯示，隨著氣壓差的增大，薄膜的最大擴張量也隨之上升，但薄膜能夠承受的氣壓差負載是有限的，因此其最大擴張量不會無限增長，而是逐漸趨於平緩。

Time: 10/5/2024 Sat 15:26-15:44

Location: Nusantaria B 1F

Paper Number: 1069

以拓樸最佳化法設計二維寬能隙聲子晶體

鄭博文 [1], 張湘淇 [1], 張怡玲 [1,*]

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近年來常利用聲子晶體的能隙特性來達成聲波或彈性波的抗噪或隔震應用，本研究基於雙向演進式結構最佳化法結合有限元素法對二維聲子晶體的彈性波能隙進行拓樸最佳化，聲子晶體由兩種不同的固體材料(環氧樹脂、金)組成，為正方形晶格排列的週期結構，分別針對出平面波(out-of-plane waves)和平面波(in-plane waves)進行能隙最大化，再將最佳化之拓樸結果與文獻進行比對驗證，並討論拓樸最佳化過程會遇到的問題及其解決方法。最後透過參數分析，探討材料性質(密度、剛性等)對能隙的影響及其最佳化之拓樸形狀。

Time: 10/5/2024 Sat 15:44-16:02

Location: Nusantaria B 1F

Paper Number: 1085

應用卷積神經網路辨識鐵軌背向散射導波譜圖

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鐵軌導波訊號的缺陷辨識一直都是個艱難的課題，鐵軌的斷面幾何複雜，缺陷或不連續斷面都會使得導波傳遞產生背向散射，鐵軌導波具有多模態及頻散特性，運用長距離或短距離的背向散射導波訊號辨識鐵軌的缺陷或不連續斷面，都具有挑戰性，後者尤其困難。本研究應

用基於二維快速傅立葉轉換的方向濾波器，自多筆缺陷的 B-scan 訊號析出反傳導波頻譜，以卷神經網路辨別缺陷種類。以往的研究中，至少需要 60 筆 B-scan 訊號轉換獲得的譜圖才有較佳的辨識度，基於檢測成本及時間效益，本研究運用卷積神經網路辨識圖片特徵的優異能力，探討減少訊號筆數仍能有效分辨缺陷種類可行性，並比較 40、30、20 筆的準確率。

Time: 10/5/2024 Sat 16:02-16:20

Location: Nusantaria B 1F

Paper Number: 1088

超音波流量計之高溫波導研究

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監測高熱燃油或液體流量之傳感器在高溫環境下操作，需兼顧高溫耐受及波傳特性。本文以有限元素法分析高溫波導之熱傳與超音波導波傳遞特性。波導的幾何形狀對熱傳導效率影響重大，需要平衡超音波導波群速度與降低熱傳溫度分布。波導內的超音波為水平偏振剪力波及對稱蘭姆波，前者先抵達然後折射進入管壁，後者抵達較遲。超音波換能器採用壓電陶瓷元件，入射於截面積小、熱阻大之平板波導或聲子晶體波導，可避免元件壓電性減損。聲子晶體波導結合平板波導及空氣高熱阻的特性，能進一步降低溫度。

SS6-C: AI (Chinese)

Time: 10/5/2024 Sat 13:00-14:30

Chair: Che-Hwa Yang

Time	Title		Author	Location
13:00-13:18	1005	非破壞射線檢測人工智慧影像辨識及輔助判片系統之應用	黃炳森, 黃啟貞, Jocelyn	Nusantaria A 1F
13:18-13:36	1029	人工智慧於雙層骨骼系統材料參數之預測	黃佳志, 陳禹丞, 楊哲化	
13:36-13:54	1038	基於蘭姆波頻散關係預測材料機械性質的人工智慧系統開發	鄭彥榕, 林元柏, 楊哲化	
13:54-14:12	1066	以深度學習分類敲擊回音時頻圖頻率組成	葉柏涼, 高瑋澤, 劉佩玲	
14:12-14:30	1073	人工智慧助力-提升檢測師判讀的經驗	李秉鴻, 林建凱, 佘國禎, 洪鍏, 朱民宏	

Time: 10/5/2024 Sat 13:00-13:18

Location: Nusantaria A 1F

Paper Number: 1005

非破壞射線檢測人工智慧影像辨識及輔助判片系統之應用

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RT 底片導入 AI 影像擷取及處理,採用深度學習演算法進行大數據訓練產生 AI 推論模組,進行瑕疵判釋。採用 Sliding Window 偵測模式,以控制瑕疵在模型輸入影像中的占比,確保偵測的準確度；使用影像分割模型以準確辨識瑕疵位置與尺寸。依據傳統底片透過底片數位化建立 AI 非破壞性檢測的資料庫,及非破壞射線檢測 AI 輔助判片技術。改良傳統人力為主之產業型

態,強化產業自動化及 AI 化水準。希望透過 AI 影像判讀技術,加快判讀速度,降低成本,減低瑕疵漏判之風險，提高檢測準確度，提升 RT 檢測的可重複性和可靠度。

Time: 10/5/2024 Sat 13:18-13:36

Location: Nusantaria A 1F

Paper Number: 1029

人工智慧於雙層骨骼系統材料參數之預測

黃佳志 [1,*], 陳禹丞 [1], 楊哲化 [2]

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在本研究中，我們提供了另一種更快速且精確的替代方法來預測雙層骨骼系統中的皮質骨厚度與海綿骨密度。研究中，我們使用 Python 程式語言結合部分波分析法獲取雙層骨骼系統的頻散圖，這一圖表可揭示雙層骨骼的材料特性和結構細節。接著同樣利用 Python 建立用於預測雙層骨骼材料參數的 CNN-LSTM 模型。透過訓練 CNN-LSTM 模型，我們能夠從頻散圖預測出雙層骨骼的皮質骨厚度和海綿骨密度，這些預測對於骨質疏鬆症的早期診斷及進一步的治療計劃制定至關重要。

Time: 10/5/2024 Sat 13:36-13:54

Location: Nusantaria A 1F

Paper Number: 1038

基於蘭姆波頻散關係預測材料機械性質的人工智慧系統開發

鄭彥榕 [1,*], 林元柏 [1], 楊哲化 [2]
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本研究以人工智慧的深度學習（Deep Learning, DL）為基礎，利用蘭姆波的頻散曲線中相速度與頻率的關係預測出材料機械性質，透過開發高精度高速之預測應用在全域性材料機械參數的系統，使用程式語言 Python，在多種演算法模型中選擇一個較適合且高效率的模型，設定不同的超參數，調整至能預測較準確的數值，在短時間內學習蘭姆波的頻散曲線並準確預測材料的多種材料機械參數數值，期望能將此技術應用於現場檢測，提高可行性、即時性與實用性。

Time: 10/5/2024 Sat 13:54-14:12
Location: Nusantaria A 1F
Paper Number: 1066

以深度學習分類敲擊回音時頻圖頻率組成

葉柏涼 [1], 高瑋澤 [2], 劉佩玲 [2,*]
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敲擊回音法廣泛應用於混凝土缺陷檢測，傳統分析方式乃觀察傅立葉頻譜中的回音尖峰以換算反射界面深度，但無法區分界面是鋼筋或裂縫。本研究設計一深度學習網路結構用來分類時頻圖上之頻率組成為鋼筋回音、裂縫回音，或其他。由於訓練深度學習模型需要大量數據，研究中以數值模擬產生大量敲擊回音訊號來訓練模型，再以數值與實驗訊號混合之資料集測試模型準確率。此外亦在模擬訊號中添加強度為 0~5%表面波最大振幅之白噪音用來增加數據量及使模擬接近實驗訊號。接著，敲擊回音訊號被轉換為 Reduced Interference Distribution

時頻圖，並在時頻圖上擷取能量最大三筆頻率訊號做為輸入來訓練一結構為 4 層卷積層的深度學習模型。結果顯示模擬數據的辨識準確率為 98.8%，實驗數據辨識準確率為 100%。

Time: 10/5/2024 Sat 14:12-14:30

Location: Nusantaria A 1F

Paper Number: 1073

人工智慧助力-提升檢測師判讀的經驗

李秉鴻 [1,*], 林建凱 [1], 佘國禎 [1], 洪鍏 [1], 朱民宏 [1]

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煉製、石化工業廠內管線腐蝕與裂紋一直是影響管線安全的主要因子，如何有效定位瑕疵與定量其嚴重度是非破壞檢測行業相當重視的議題。導波檢測在 30 年前發展出可以定位包覆下腐蝕與管支撐腐蝕的所在位置但僅能定性分級其嚴重度，近年來高頻短程導波發展出可以定量分析管支撐腐蝕之剩餘厚度且導入機器學習模式將人工智慧 AI 應用在協助檢測師分析高頻導波訊號。本文主要分享以檢測師角度在使用設備內建人工智慧判讀平台時，需要注意的環節，包括檢測方法極限的認知、人工智慧判讀結果之拿捏以及檢測師之職責。AI人工智慧輔助會是毒藥還是神器，端看我們怎麼使用它。

SS6: AI

Time: 10/4/2024 Fri 15:20-16:32

Chair: Che-Hwa Yang

Time		Title	Author	Location
15:20-15:38	1041	A Single-Microphone Multi-Channel Handheld Device for Sound Detection	Wei-Rui Lee, Yen-Ru Shih, Pin-Cheng Chen, Cheng-Liang Chen, Hao-Yeh Lee, Po Ting Lin	Nusantaria B 1F
15:38-15:56	1050	Defect Detection in Decorative Panels Using Deep Convolutional Neural Networks	Yu-Hsien Chan, Chao-Ching Ho	
15:56-16:14	1054	META-C: Deep Learning Pipeline for Detecting Anomalies on Complex Multimodal Vibration Sewage Treatment Plant Data	Andrew Yeung, Jason Li, Nigel Ko, Wing-Lam Yan, Simeon Krastev, Aukkawut Ammartayakun, Kewal Jayshankar Mishra, Harika Koduri, Eric Schuman, Drew Morris, Yuan Feng, Sai Supreeth Reddy Bandi, Chun-Kit Ngan, Fatemeh Emdad, Elke Rundensteiner, Heiton M.H. Ho, T.K. Wong, Jolly P.C. Chan	
16:14-16:32	1057	AI for Classification and Depth Prediction of Defect Signals of Eddy Current Test for Heat Exchanger Tubes	Yi-Ting Teng, Peng-Yu Chen, Wei-Jin Wu, Yun-Cheng Ku, Yong-Hao Gao, Yan-Cheng Chen, Mao-Kuen Kuo, Jiunn-Woei Liaw	

Time: 10/4/2024 Fri 15:20-15:38
Location: Nusantaria B 1F
Paper Number: 1041

A Single-Microphone Multi-Channel Handheld Device for Sound Detection

Wei-Rui Lee[1], Yen-Ru Shih[1], Pin-Cheng Chen[1], Cheng-Liang Chen[2], Hao-Yeh Lee[3], Po Ting Lin[1,4,5,*]

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This paper presents the design and development of a Single-Microphone MultiChannel (SMMC) handheld device for sound detection. Building on previous work that utilized a semi-spherical structure, this study introduces a fully spherical device with a diameter of 9.8 cm, made of polydimethylsiloxane (PDMS) and formed through molding. The device has eleven sound-suppressing channels of varying shapes, evenly distributed across the spherical structure with a single microphone positioned at the center. The device is designed to determine the position of a sound source. Experiments were conducted at 31 different sound positions, with each experiment repeated three times, resulting in a total of 93 data sets. Frequency responses from these experiments were analyzed using Fourier Transform and a Convolutional Neural Network (CNN), yielding a sound localization accuracy with an angular error of 5.717°. The study demonstrates the effectiveness of the proposed device in accurately determining the direction of incoming sounds regardless of the rotation of the handheld device.

Time: 10/4/2024 Fri 15:38-15:56
Location: Nusantaria B 1F
Paper Number: 1050

Defect Detection in Decorative Panels Using Deep Convolutional Neural Networks

Yu-Hsien Chan[1], Chao-Ching Ho[1,*]
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Decorative panels come in a variety of textures and patterns. The main defects include stains, white spots, insect marks, cracks, and lines, which pose significant challenges for product quality management and visual inspection. This study employs the Convolutional Neural Network (CNN) UNet++ for defect detection across different imaging devices and decorative panel patterns, aiming to improve inspection efficiency and accuracy. Additionally, through the use of transfer learning techniques, different wood grain textures are converted into enhanced images, improving the model's adaptability to various textures and enhancing detection accuracy. Experimental results demonstrate that transfer learning significantly improves defect detection on decorative panels. The non-transferred model achieved an average Intersection over Union (IoU) of 69.85% on the test set, while the IoU improved to 85.56% after transfer learning. The UNet++ model accurately identifies defect areas within images, and transfer learning enhances the model's ability to recognize and inspect various textures. The combination of these two techniques results in higher accuracy for defect detection in decorative panels.

Time: 10/4/2024 Fri 15:56-16:14
Location: Nusantaria B 1F
Paper Number: 1054

META-C: Deep Learning Pipeline for Detecting Anomalies on Complex Multimodal Vibration Sewage Treatment Plant Data

Andrew Yeung[1], Jason Li[1], Nigel Ko[1], Wing-Lam Yan[1], Simeon Krastev[2], Aukkawut Ammartayakun[2], Kewal Jayshankar Mishra[2], Harika Koduri[2], Eric Schuman[2], Drew Morris[2], Yuan Feng[2], Sai Supreeth Reddy Bandi[2], Chun-Kit Ngan[2], Fatemeh Emdad[2], Elke Rundensteiner[1], Heiton M.H. Ho[3], T.K. Wong[3], Jolly P.C. Chan[3]

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In this paper, we introduce a hybrid anomaly detection pipeline named META-C, which combines Multimodalfeature Extraction (ME) and a Transformer-based Autoencoder (TA) with additional Classifier (C) to harness the strengths of these methodologies for predictive maintenance of sewage treatment plants. Our approach is three-pronged. First, META-C employs a signal averaging method to preprocess raw sensor data, effectively removing unrelated noise and enhancing the quality of signals pertinent to pump health and operations. Second, META-C utilizes Multimodal-feature Extraction techniques to extract significant signal properties from three vibration signal directions (Axial, Radial X, and Radial Y). These extracted features are then fused and subjected to dimension reduction to produce a refined PCA feature set. Third, META-C leverages a Transformer-based Autoencoder (TA) model with additional classification head to learn pump behavior from the PCA feature set, enabling the detection of anomalous behavior over time with high precision. We conducted an extensive experimental case study on the Stonecutters Island Sewage Treatment Works in Hong Kong, demonstrating that our META-C model outperforms state-of-the-art methods in terms of key performance metrics such as MCC and F1-score. Additionally, we developed a web-based

prototype for a Sewage Pump Monitoring System that hosts the entire META-C pipeline, providing an interactive user interface for future use.

Time: 10/4/2024 Fri 16:14-16:32

Location: Nusantaria B 1F

Paper Number: 1057

AI for Classification and Depth Prediction of Defect Signals of Eddy Current Test for Heat Exchanger Tubes

Yi-Ting Teng[1], Peng-Yu Chen[1], Wei-Jin Wu[2], Yun-Cheng Ku[1,2], Yong-Hao Gao[1], Yan-Cheng Chen[2], Mao-Kuen Kuo[1], Jiunn-Woei Liaw[2,3,*]

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This study investigates methods for defect classification and depth prediction using four-frequency eddy current testing (ECT) data. Four-frequency phase angles as features are utilized, with a random forest model applied for defect classification and an artificial neural networks (ANN) model for defect depth prediction. The results indicate that the random forest classifier achieves high accuracy in defect classification, and the ANN model provides precise depth predictions. These findings demonstrate the potential of applying artificial intelligence (AI) to practical applications in ECT data.

SS7-C: Civil NDT (Chinese)

Time: 10/5/2024 Sat 14:50-16:20

Chair: Chia-Chi Cheng

Time	Title		Author	Location
14:50-15:08	1003	以 ISO 17636-1 規劃管線 RT 照相計算程式	董寶鴻	Nusantaria A 1F
15:08-15:26	1040	逆擴展有限元素法應用於損傷結構之結構健康監測	戴名駿	
15:26-15:44	1052	超高速傳輸線之線上檢測	蔡博恩, 甘政倫, 李壽南, 劉育翔, 許世明, 何昭慶	
15:44-16:02	1053	智慧工場-應用無人飛行器於儲槽檢測	許博誠, 李秉鴻	
16:02-16:20	1070	陣列式超音波、輔助研判及雲端管理系統在設備管線銲道品質檢查運用	黃宗傑, 蔣政剛, 黃志輝	

Time: 10/5/2024 Sat 14:50-15:08

Location: Nusantaria A 1F

Paper Number: 1003

以 ISO 17636-1 規劃管線 RT 照相計算程式

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本文主要從 ISO 17636-1 角度來討論目前台灣 CNS 11226 銲接 RT 標準有不足之處，提出未來 CNS 11226 建議修訂的方向，應補強項目一共有 6 項。另外透過建立底片特性曲線的近似曲線與 ISO 17636-1 的規範限制條件內容，建立 Excel 計算公式程式，輔助 RT 檢測人員可以正確使用 ISO 標準執行管線 C 線銲接檢驗，並試用一管線 C 線銲接案例驗證此計算程式的效率。

Time: 10/5/2024 Sat 15:08-15:26

Location: Nusantaria A 1F

Paper Number: 1040

逆擴展有限元素法應用於損傷結構之結構健康監測

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近年逆有限元素法(iFEM)已經被證實能夠根據有限數量應變感測器來有效監測即時變形和應力結構響應並偵測結構缺陷，然而該領域文獻中尚未針對損傷結構的結構健康監測展開更進一步的討論。本研究開發一逆擴展有限元素法(iXFEM)用於執行損傷結構的破壞力學行為監測，與傳統 iFEM 方法相比，iXFEM 數值框架中引入水平集方法(Level-set method)和強化形狀函數(Enriched shape functions)來模擬裂紋尖端周圍的幾何不連續現象。本研究針對感測器佈置、收斂速度以及破壞力學參數進行一系列分析，數值結果證明 iXFEM 能基於有限應變感測器數據來預測各類型損傷結構之破壞力學行為。

Time: 10/5/2024 Sat 15:26-15:44

Location: Nusantaria A 1F

Paper Number: 1052

超高速傳輸線之線上檢測

蔡博恩 [1], 甘政倫 [1], 李壽南 [2], 劉育翔 [2], 許世明 [2], 何昭慶 [3,*]

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在工業上對於訊號的傳輸速度及品質需求逐年增加，因此對於訊號傳輸高速傳輸線對於線徑檢測有著嚴苛的要求。本研究目的在建立即時的線上檢測系統，用於檢測多芯高速傳輸線的線徑。本研究設計高速傳輸線之檢測架構，針對傳輸線包覆材料 HDPE 選擇特定波長的光源，利用機器視覺技術拍攝並分析線材圖像，進行線徑測量。透過光譜儀量測，在 600-700 nm 波段對 HDPE 具有較高的穿透性，因此選擇紅色背光板作為光源，並透過影像處理，即時計算多條線徑尺寸，檢測結果顯示，本研究之系統的測量精度達到±10%以內。

Time: 10/5/2024 Sat 15:44-16:02
Location: Nusantaria A 1F
Paper Number: 1053

智慧工場-應用無人飛行器於儲槽檢測

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在石化工業中，儲槽、管線和壓力容器等設備的檢測與監測至關重要，尤其在智慧工場的建立過程中。傳統檢測方法主要集中於儲槽底板的完整性，而壁板與頂板的檢測往往因施工困難而被忽視。然而，隨著環境部對揮發性有機物(VOCs)管制的加強，壁板與頂板的腐蝕或裂紋可能導致 VOCs 洩漏，這些風險不容忽視。本文探討了如何利用無人飛行器 Elios 3 UT 技術在飛行過程中構建設備的數位孿生模型，並進行目視檢查及超音波檢測，尤其針對壁板和頂板的厚度進行精確測量。這一技術不僅提高了檢測效率，還能有效地管理檢測數據，為工場內儲槽的智慧化管理奠定了堅實基礎。

Time: 10/5/2024 Sat 16:02-16:20
Location: Nusantaria A 1F
Paper Number: 1070

陣列式超音波、輔助研判及雲端管理系統在設備管線銲道品質檢查運用

黃宗傑 [1,*], 蔣政剛 [1], 黃志輝 [1]

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傳統放射性 RT 執行時，依法規環境需進行管制，故現今 NDT 檢測技術已有使用陣列式超音波(PAUT-Phased array ultrasonic testing)檢查來取代 RT。本企業將陣列式超音波(PAUT)、輔助研判系統(ADT-Automated Detection Technology)及雲端管理系統彙整一起。將陣列式超音波(PAUT)數位資訊，藉由 ADT 輔助，提供標準化研判，最後藉由雲端管理系統(PACM-Phased array Cloud management system)，將數位化數據傳輸及管理，提供立即性檢測結果，並配合簡訊通知，讓緊急工程所需時間縮短，提高設備管線生產效率。

SS7: Civil NDT

Time: 10/4/2024 Fri 13:30-15:00

Chair: Chia-Chi Cheng

Time	Title		Author	Location
13:30-14:06	Keynote	Revolutionizing Infrastructure Management with NDT	Tomoki Shiotani	Nusantaria B 1F
14:06-14:24	1039	UAV-based Structure Inspection with Automatic Path Planning with Obstacle Avoidance	Pin-Cheng Chen, Ching-Yuan Chang, Kuan-Yen Liu, Po Ting Lin	
14:24-14:42	1047	Research on the Use of YOLO Algorithm Based on Convolutional Neural Networks for Detecting void Signals in Ground Penetrating Radar Images	Keng-Tsang Hsu, Yi-Chu Huang, Yi-Wen Wang	
14:42-15:00	1055	Assessing Damage of Concrete Plate Cold Joint using the Dispersion of Rayleigh Wave Velocity Profiles	Chia-Chi Cheng, Yung-Chiang Lin, Ting-Yu Lin, Hong-Yao Tsai	

Time: 10/4/2024 Fri 13:30-14:06

Location: Nusantaria B 1F

Keynote

Revolutionizing Infrastructure Management with NDT

Tomoki Shiotani*

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The maintenance of aging infrastructure, particularly in regions like Japan, has become critical due to growing maintenance demands and limited resources. In this paper, we propose innovative non-destructive testing (NDT) solutions that tailor to the risk levels of different infrastructures. For low-risk, remote areas, we employ energy-harvesting sensors for binary condition assessment. High-risk

urban areas, on the other hand, require detailed damage visualization, achieved using elastic wave sensors. These sensors were applied to both the construction and in-service phases of a concrete bridge deck, demonstrating their effectiveness in crack detection and structural integrity assessment. The results emphasize the need for adaptive NDT strategies, optimized resource allocation, and integration of internal data with surface-level information for comprehensive infrastructure health assessment.

Time: 10/4/2024 Fri 14:06-14:24

Location: Nusantaria B 1F

Paper Number: 1039

UAV-based Structure Inspection with Automatic Path Planning with Obstacle Avoidance

Pin-Cheng Chen[1], Ching-Yuan Chang[2], Kuan-Yen Liu[3], Po Ting Lin[1,4,*]

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In this paper, a new method of path planning of Unmanned Aerial Vehicle (UAV) with obstacle avoidance was shown for structure inspections in the civil engineering applications. The proposed system first utilized Structure from Motion (SfM) to reconstruct the 3D model of the structure from multiple 2D images taken from the UAV. For more precise positioning of the UAV relative to the structure, a cyber-physical approach was then established, which started from pattern recognition and 3D model matching. A safe flying trajectory was then determined by a Lagrangian minimization approach in the cyber space. Lastly, the optimal flying positions were sent to the UAV controller to complete the desired inspection mission. The presented approach was validated through simulated and practical scenarios, demonstrating the effectiveness of the proposed cyber-physical UAV-based

inspection system for real-time calculations of safe path planning and inspection with desired accuracy.

Time: 10/4/2024 Fri 14:24-14:42

Location: Nusantaria B 1F

Paper Number: 1047

Research on the Use of YOLO Algorithm Based on Convolutional Neural Networks for Detecting void Signals in Ground Penetrating Radar Images

Keng-Tsang Hsu[1,*], Yi-Chu Huang[1], Yi-Wen Wang[1]

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Ground-penetrating radar (GPR) is a commonly used non-destructive testing method in engineering. After completing on-site testing, it is typically necessary to interpret and analyze the image signals, a process that usually relies on manual post-processing and analysis, with inspectors marking defects in the images. This process is both time-consuming and tedious. To improve detection efficiency and reduce the time required for preliminary analysis, this study attempts to apply object detection techniques in deep learning to train a model that can identify cavity defect features in radar images, thereby providing faster identification results to assist inspectors in interpreting radar images. This research utilizes YOLOv4 to train a model on 2D radar profile images of embankment cavities. By adjusting YOLO's hyperparameters and optimizing the training set images, test results indicate that various methods have enhanced the model's recognition capability. These improvements have significantly increased the model's ability to identify cavity defects in groundpenetrating radar images, aiding technicians in more efficiently interpreting and marking these images.

Time: 10/4/2024 Fri 14:42-15:00
Location: Nusantaria B 1F
Paper Number: 1055

Assessing Damage of Concrete Plate Cold Joint using the Dispersion of Rayleigh Wave Velocity Profiles

Chia-Chi Cheng[1,*], Yung-Chiang Lin[1], Ting-Yu Lin[1], Hong-Yao Tsai[1]
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[*]Corresponding Author: cccheng@cyut.edu.tw

This study aims to develop a technology for assessing the interfacial condition of cold joints in concrete plates by focusing on the dispersion velocity profile of surface waves. The methodology involves using a small impact hammer with an embedded piezoelectric element and a displacement receiver strategically placed on either side of the seam. In this initial investigation, numerical models were created using ANSYS LS-DYNA. The cold joint zone was simulated by randomly removing elements to achieve a predetermined void ratio. Displacement waveforms at the sensor node were analyzed using a short-time Fourier Transform and the reassigned method to derive the dispersive velocity profile of surface waves. The study explores the effects of impact durations and void distributions. Numerical results indicate that cold joints are detectable with a void ratio of 40% or greater. For void ratios of 60% and 80%, surface wave velocities are significantly lower for wavelengths below 0.1 m and 0.2 m, respectively. For surface-observable cold joints with the same porosity ratio, a smaller extension depth results in lower wave velocity on the dispersion curve compared to a fully penetrated cold joint. The study finds that a contact duration of 60 μs and an impactor-receiver distance of 0.82 m provide the most distinguishable results for detecting a cold joint's extension and porosity ratio. Finally, various void distributions in the cold joint primarily affect the wave velocity at shorter wavelengths.

UT-C: Ultrasonic Testing (Chinese)

Time: 10/5/2024 Sat 13:00-14:30

Chair: Kun-Yi Tsai, Po Ting Lin

Time	Title		Author	Location
13:00-13:18	1004	小管徑金屬管套接銲道相位陣列超音波檢測	李紹喜, 陳慶原, 陳豪韋, 劉昶廷	Nusantaria D 1F
13:18-13:36	1008	航太鋁合金擠型件超音波檢測之客戶認證歷程研究	陳世峯, 蕭天文, 洪呈凱	
13:36-13:54	1060	PAUT、TOFD 與 CWUT 對於內表面裂紋檢出能力及分析探討	邱雍惟, 郭榆丞, 黃啟貞	
13:54-14:12	1072	疲勞裂紋的專武-陣列超音波相位相干成像技術	李秉鴻, 朱民宏, 殷菘偉, 李博裕, 謝文棟	
14:12-14:30	1082	非線性超音波用於缺陷幾何形狀偵測	羅裕翔, 馮浚, 尹慶中	

Time: 10/5/2024 Sat 13:00-13:18

Location: Nusantaria D 1F

Paper Number: 1004

小管徑金屬管套接銲道相位陣列超音波檢測

李紹喜 [1], 陳慶原 [1,*], 陳豪韋 [1], 劉昶廷 [1]

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台電公司電廠於 112 年大修起動時，AB-004-2"-DCD 與 AB-004-8"-DBD 間碳鋼與不銹鋼之小管徑套接異質銲道發生洩漏，因應管路銲道破損，112.6.20 決議：管制機關以備忘錄管制本案改善措施(下次大修換管)，為防止類似事件發生，電廠相關課組將針對小尺寸之碳鋼與不銹鋼異質銲道，持續研究非破壞體積檢測之做法，依規劃、校準、檢測、研判、驗證完成整體作業。本文介紹使用相位陣列超音波檢查小尺寸碳鋼與不銹鋼異質銲道之技術建置與在廠陣列超音波檢測程序書能力驗證結果。

Time: 10/5/2024 Sat 13:18-13:36
Location: Nusantaria D 1F
Paper Number: 1008

航太鋁合金擠型件超音波檢測之客戶認證歷程研究

陳世峯 [1,*], 蕭天文 [2], 洪呈凱 [3]

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鋁合金擠型件具輕量及高強度的特性，普遍應用於航太產品之次要結構上，而基於飛航安全的考量，飛機製造公司要求厚度大於 0.5 in 之鋁擠，即須執行超音波 (UT) 檢驗內部瑕疵，為了確保供應商之 UT 檢測能力，則必須取得客戶 UT 認證。客戶鋁合金擠型件 UT 認證包括非破壞檢測人員，超音波檢測設備，以及技術指引 (Technique Data Sheet, TDS)。非破壞檢測人員認證必須符合 NAS 410 需求，並由客戶認證之 Professional NDT Level 3 認證。超音波檢測設備包括 UT 儀器、掃描機構、探頭及標準規塊，須滿足客戶要求之檢測能力。TDS 則在規定檢測之人員資格、設備、物料、技術、參數及允收標準等，以確保檢測結果之可靠度及可重現性。因為本案例為新建立之 UT 人員、設備及檢測技術，所以在客戶認證之前，必須先取得 NADCAP 認證，因此執行了完整的 NDI 能量建置及認證程序，驗證了航太鋁合金擠型件超音波技術之檢測能力。

Time: 10/5/2024 Sat 13:36-13:54

Location: Nusantaria D 1F

Paper Number: 1060

PAUT、TOFD 與 CWUT 對於內表面裂紋檢出能力及分析探討

邱雍惟 [1,*], 郭榆丞 [1], 黃啟貞 [1]

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近年來輻射防護安全意識抬頭，事業單位以及檢測從業人員都開始多加利用先進的檢測技術來替代 RT，而超音波也是一種能有效檢出內部瑕疵的檢測方法。對運轉中設備的重點是在檢測內部是否有微小的裂紋產生，以及檢測人員是否能準確的訊號判讀，不讓小裂紋被忽略，而傳統超音波無法將訊號連續記錄，因此能將訊號圖像記錄的相位陣列式超音波(PAUT)與飛行時間繞射法(TOFD)成為了首選，然而爬行波(CWUT)又是一種有效檢出垂直內表面裂紋之另一特定技術，以上三種技術均能檢出內表面裂紋，所以本文以 PAUT、TOFD 及 CWUT 對於內表面裂紋的檢出能力、裂紋深淺(高度)及訊號判讀難易列入考慮，以規塊及試片實驗來作比較分析和探討。希望藉此了解三種技術的鑑別能力作為檢測程序制定之參考或依據。

Time: 10/5/2024 Sat 13:54-14:12

Location: Nusantaria D 1F

Paper Number: 1072

疲勞裂紋的專武-陣列超音波相位相干成像技術

李秉鴻 [1,*], 朱民宏 [1], 殷菘偉 [2], 李博裕 [3], 謝文棟 [3]

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在煉製、石化工業或發電廠中，壓力容器設備或管線經常因操作產生疲勞裂紋。外表面裂紋可用液滲或磁粒檢測，內表面裂紋則多採用超音波技術。近年來，陣列超音波因能提供多方位的訊號評估及掃描訊號記錄，已成為檢測的常用方法。裂紋形貌分為多種，其中疲勞裂紋通常垂直於內壁成長且無分支，難以用斜束超音波檢測來進行裂紋高度定量。使用陣列超音波相位相干成像（PCI）技術增強了疲勞裂紋尖端的繞射波訊號，降低底面反射訊號，使裂紋更易分辨和量化。本文中採用直束 PCI 來掃描一裂紋試片可快速且清楚看到裂紋分布與裂紋最嚴重的位置與尺寸，提供更準確檢出和疲勞裂紋定量結果。

Time: 10/5/2024 Sat 14:12-14:30

Location: Nusantaria D 1F

Paper Number: 1082

非線性超音波用於缺陷幾何形狀偵測

羅裕翔 [1], 馮浚 [1], 尹慶中 [1,*]

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本文應用非線性超聲導波評估鋁合金 6061 材料特性。透過滿足非零功率通量及相速度匹配激發基頻與同步產生的高階諧波觀察非線性超聲導波遇到板中缺陷後模態的改變，對周圍的缺陷進行精確檢測。這對於確保結構的整體性能、安全性及耐久性至關重要，特別是在要求高度可靠性的應用環境中。通過這種方法能夠更全面地了解結構的動態行為，提供了全面且靈活的解決方案，進一步提高結構的性能及預測其潛在發生的問題。

NDT-C: NDT-General (Chinese)

Time: 10/5/2024 Sat 14:50-16:20

Chair: Jin-Jhy Jeng, Ping Hung Lee

Time	Title		Author	Location
14:50-15:08	1015	各國 NDT 能力試驗活動差異說明	楊智詠, 翁德富	Nusantaria D 1F
15:08-15:26	1020	HDPE 套管對鋼鉸線的振動行為造成之影響	鍾保寅, 賴建宏, 余志鵬	
15:26-15:44	1045	以 EPS 法建立 CR 系統之靈敏度基準	王之斌	
15:44-16:02	1058	陰影疊紋量測技術用於晶圓翹曲量測之開發	賈皓文, 謝宏麟, 李朱育, 曹庭豪	
16:02-16:20	1083	連續損傷模型應用於航空複材結構損傷預測	梁育瑞	

Time: 10/5/2024 Sat 14:50-15:08

Location: Nusantaria D 1F

Paper Number: 1015

各國 NDT 能力試驗活動差異說明

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中鋼非破壞檢驗課為 TAF 認證之 ISO 17025 實驗室。除了定期參加能力試驗執行機構(P009)定期辦理之能力試驗活動外，於 2018 年起，陸續參加各國際能力試驗活動，迄今已分別參加過 CNIL、PTA 與 ATG 能力試驗機構。本篇研究比較能力試驗參與活動過程、經驗與結果進行說明，其中最大相異處有(1)統計分析方法不同：P009 與 CNIL 皆採用穩健統計方法(Robust)，而 PTA 與 ATG 採用真值作為分析；(2)報告列入評分結果：為 PTA 與 ATG 皆將報告內容列入評分，與 P009、CNIL 活動方法不同。

Time: 10/5/2024 Sat 15:08-15:26

Location: Nusantaria D 1F

Paper Number: 1020

HDPE 套管對鋼絞線的振動行為造成之影響

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在進行纜繩振動量測時，感測器通常安裝在 HDPE 套管上。然而，纜繩的真實振動行為主要由內部的鋼絞線決定，因此在套管上量測可能會導致訊號不夠準確。本研究旨在探討當量測纜繩訊號時，將感測器放置於套管上與放置於鋼絞線上是否會產生差異。為此，我們建立了兩個數值模型來分析纜繩在具套管包覆時，及無套管下的振動行為。通過參數研究我們發現兩模型皆呈現非常接近的振頻值，這代表兩種模型的計算結果基本一致。此外，我們也對此進行了現地試驗，在切除纜繩 HDPE 套管前後分別進行了訊號量測。在進行量測後，發現兩組訊號並無顯著差異。因此，本研究結果說明，在現場量測時，將感測器安裝於 HDPE 套管，基本上不會對振動頻率的測量結果產生顯著影響。

Time: 10/5/2024 Sat 15:26-15:44

Location: Nusantaria D 1F

Paper Number: 1045

以 EPS 法建立 CR 系統之靈敏度基準

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當前以 CR(Computed Radiography)掃描器及數位影像板(Image Plate, IP)取代底片做為射線檢測影像載體之應用已十分成熟，其不僅省卻了暗房與廢水處理設備的設置，且影像板可重複使用數千次。兩者除了在沖/洗底片及判片方式有所差異外，其曝光操作方式大同小異。雖然曝光 IP 與曝光底片的操作方式類似，然而直接以曝光底片之技術去曝光 IP，可能無法如期得到理想之影像。其中 CR 系統靈敏度測試，不僅可用來做為 CR 影像系統的基準、持續監控系統之穩定性，同時提供 IP 影像最低可受像素值之依據。本文期以 EPS (Equivalent Penetrameter Sensitivity)法建立 CR 影像系統之靈敏度基準，並探討 X 光機對 CR 系統曝光量之有效範圍與限制。

Time: 10/5/2024 Sat 15:44-16:02

Location: Nusantaria D 1F

Paper Number: 1058

陰影疊紋量測技術用於晶圓翹曲量測之開發

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本研究成功開發出一套「陰影疊紋量測技術」，並將其應用於 12 吋晶圓的翹曲量測。此套「陰影疊紋量測技術」由 LED 光源、線性光柵、晶圓定位模組、影像擷取模組及影像分析模組所組成，其架構簡單且易於實踐。當 LED 光源入射至線性光柵後，會在待測晶圓表面形成光柵陰影，經疊合光柵及其陰影後即可形成相對應的疊紋影像，透過自行開發的影像分析模組分析該疊紋影像後，即可重建出待測晶圓的高度變化(翹曲)資訊。實驗結果顯示，此套技術能夠一次性量測大尺寸晶圓的翹曲資訊，具備優異的量測能力，日後能廣泛應用於晶圓的翹曲量測場合中。

Time: 10/5/2024 Sat 16:02-16:20
Location: Nusantaria D 1F
Paper Number: 1083

連續損傷模型應用於航空複材結構損傷預測

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由於複材疊層結構優異的高強度、高剛度與重量比表現，使其廣泛應用在現代化飛機結構的典型複合材料結構形式。但由於複材疊層結構之關鍵應力區常存在複雜的應力分布，例如 T 型複材接頭，而一般傳統有限元素方法也缺乏精確預測其結構之漸進式損傷機制，因此過去幾十年來數值模擬方法在此類問題的應用上受到越來越多關注。本研究使用 Abaqus 建立 T 型複材疊層結構的有限元素模型，其中使用 NASA Langley Research Center 開發的 LaRC04 破壞準則來預測損傷起始、連續損傷模型 CDM 用來描述層內基材裂縫損傷、內聚力模型 CZM 來描述層間脫層損傷。本研究以 T 型複材接頭為例，對其結構做了完整的漸進式損傷分析。結果表明，只單獨使用內聚力模型考慮層間脫層損傷的方法不足以準確預測其漸進式損傷機制；如果同時考慮層內與層間損傷並使用連續損傷建模技術與內聚力模型，能更準確預測其結構強度以及整體之漸進式損傷行為。本研究對於瞭解複雜複材結構的損傷行為和設計應用，提供具有重要的參考價值和實際意義。

NDT-E: NDT-General (English)

Time: 10/4/2024 Fri 13:30-14:42

Chair: Ching-Chi Chen, Po Ting Lin

Time	Title		Author	Location
13:30-13:48	1013	Exploring Advanced Ultrasonic Inspection Techniques and Assessing Their Imaging and Sizing Capabilities	Prasanth Geddam	Nusantaria D 1F
13:48-14:06	1014	Solving 2D Corrosion Mapping Ultrasonic Inspection Challenges	Dennis Chai	
14:06-14:24	1019	Based on Shape from Focus Technology Measuring Internal Modified Layer Thickness of Silicon Carbide	Yu-Chen Kuo, Ji-Ru Jiang, Ju-Yi Lee	
14:24-14:42	1077	Optimizing Payload Capacity and Real-Time Grasping Analysis in Delta Parallel Robots Using PVDF/Graphene Piezoelectric Sensors	Yao-Chung Hsu, Brijesh Patel, Yu-Hsun Chen, Wei-Song Hung, Po Ting Lin	

Time: 10/4/2024 Fri 13:30-13:48

Location: Nusantaria D 1F

Paper Number: 1013

Exploring Advanced Ultrasonic Inspection Techniques and Assessing Their Imaging and Sizing Capabilities

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In recent years, there has been significant advancements in portable ultrasonic techniques such as the introduction of newer data collection methods like full matrix capture (FMC) and plane wave imaging (PWI), as well as advanced data processing algorithms like the total focusing method (TFM) and phase coherence imaging (PCI). These techniques are gaining recognition within the industry for their enhanced imaging and sizing capabilities over the traditional Ultrasonic Testing (UT) and Phased

Array Ultrasonic Testing (PAUT). However, like any ultrasonic testing (UT) method, these advanced inspection techniques are governed by the same fundamental laws of physics, and their performance relies on the input parameters used. The accuracy of results can also be affected by the properties of test component such as material composition, geometry/access etc. From physical probe characteristics to the choice wavesets for image reconstruction, a vast array of variables must be optimized to extract the best results. Therefore, a thorough understanding of the variables and operational limitations associated with these methods is essential for using them in practical applications. This presentation aims to provide a comprehensive comparison and analysis of the key parameters involved and their effect on imaging and sizing capabilities when compared to traditional focused phased array ultrasonic inspection.

Time: 10/4/2024 Fri 13:48-14:06

Location: Nusantaria D 1F

Paper Number: 1014

Solving 2D Corrosion Mapping Ultrasonic Inspection Challenges

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Ultrasonic corrosion mapping inspection using conventional single-element UT probes is slow and only capable of acquiring low-density data. Inspecting large areas using conventional UT typically requires a configuration involving complex, expansive, and difficult-to-set up motorized scanners. Offering a wider beam coverage than conventional UT, phased array ultrasonic testing (PAUT) has gained popularity in recent years for corrosion mapping, as it helps improve inspection rates while increasing data quality. Although the wider beam is an advantage, the probe still needs to be moved sideways between each scan line to perform 2D mapping of the targeted inspection area. To encode the probe's position on two axes, a typical phased array search unit needs to be mounted on an external dual encoded scanning system, further increasing the inspection costs and complexity. Evident has developed a solution to this problem—a new phased array scanner with two integrated encoders to

record its position on the part for both x- and y-axis scanning, thereby removing the need for an auxiliary scanner. This presentation will provide details on the different innovations implemented in this new system and explain how it can be used to increase productivity and data quality while reducing the costs and complexity of 2D corrosion mapping.

Time: 10/4/2024 Fri 14:06-14:24

Location: Nusantaria D 1F

Paper Number: 1019

Based on Shape from Focus Technology Measuring Internal Modified Layer Thickness of Silicon Carbide

Yu-Chen Kuo[1], Ji-Ru Jiang[1], Ju-Yi Lee[1,*]

[1]Department of Mechanical Engineering, National Central University

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This study explores the Shape from Focus (SFF) technique as a measurement method that leverages optical focusing characteristics to reconstruct the three-dimensional shape of an object. The principle of SFF involves capturing a series of images of the object's surface at various focal positions to determine the optimal focus position for each surface point. An algorithm is then employed to compute the focus clarity of each pixel across these focal positions. The focus value at a given position reflects the relative depth between the surface point and the camera.

Time: 10/4/2024 Fri 14:24-14:42
Location: Nusantaria D 1F
Paper Number: 1077

Optimizing Payload Capacity and Real-Time Grasping Analysis in Delta Parallel Robots Using PVDF/Graphene Piezoelectric Sensors

Yao-Chung Hsu[1], Brijesh Patel[1], Yu-Hsun Chen[1], Wei-Song Hung[2], Po Ting Lin[1,3,4,*]

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[2]Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology
[3]Intelligent Manufacturing Innovation Center, National Taiwan University of Science and Technology
[4]High-Speed 3D Printing Research Center, National Taiwan University of Science and Technology

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The Delta parallel robotic arm is an integral part of automated production lines for high-speed and high-precision tasks. However, evolving industrial demands necessitate advancements in the payload capacity of these robotic systems, which have traditionally prioritized speed and accuracy over heavy lifting. Addressing this challenge, this study explores the enhancement of payload capabilities in Delta parallel robots, emphasizing the critical role of motor torque, mechanical rigidity, and the end effector's clamping force. To further optimize performance, this study proposes integrating a PVDF/Graphene piezoelectric membrane sensor into the suction cup gripper to enable real-time weight detection and diagnostic analysis of grasping failures through machine learning. This integration aims to improve both the operational efficiency and reliability of the robotic arm in handling diverse objects in dynamic production environments.

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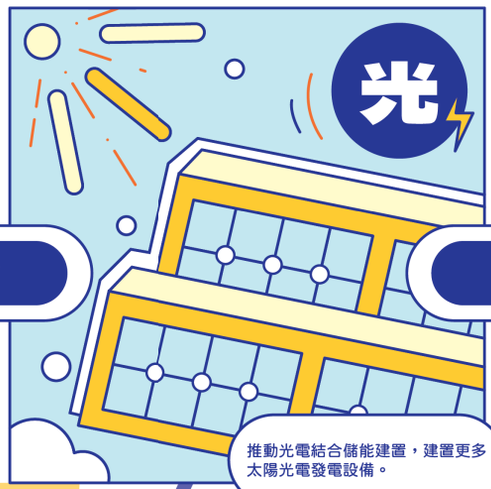
光



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熱

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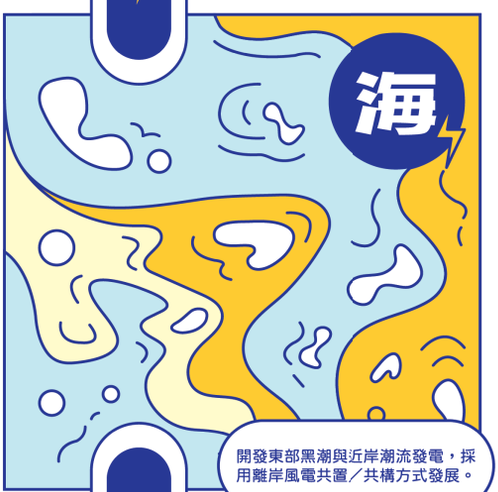
海



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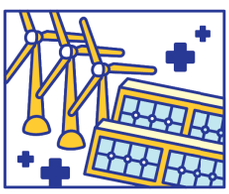

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