出國報告（其他類別：國際會議）

參加日本京都 2024 年 IEEE 第十屆應用系統創新國際會議心得報告

服務機關：台灣自來水公司資訊處

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派赴國家：日本

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摘要

參加日本京都「IEEE 國際知識創新與發明會議」除了實地發表自己的全英文論文，並且聆聽與會專家、學者在 AI 前瞻技術的研究成果，獲取了很多可用的專業知識，彼此交換研究心得，以及參訪神戶市明石海峽大橋附掛自來水管設施，成果豐碩。這些科學家前瞻研究方向及成果，很多都會在不久的將來實現於各領域及生活。我們參加大型學術活動，了解國際電機、電子及資訊趨勢並蒐集相關技術資料，做為往後研究、功能開發之參考依據。就好像在預見未來台灣發展的事情，除向國際友人介紹台灣在資訊科技及淨零排放的努力成果外，一方面瞭解未來的發展，一方面與其他國家地區進行交流，俾提高國際能見度。最重要的是，不管是專業或語文能力，期許每次去參與應該都要論文發表才能提升自我的能力，才能更具國際觀與前瞻的思考能力。

關鍵字：集中式主機、分散式主機、工業閘道主機(IGS)、淨零排放。

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一、目的

為投稿「IEEE 國際電機電子工程協會」論文口頭發表及參訪神戶市明石海峽大橋自來水管設施。論文發表題目為「A New ICT Architecture of Smart Water Network Platform for Improving Management Performance: Maintenance, Security, and Deployment Cost

」(新資訊架構供水監測平台改善管理效能:維護,安全及部署成本)。

二、過程

本次 IEEE 國際電機電子工程協會論文發表收錄來自全世界四百餘篇各領域前瞻創新應用系統論文，為造福人類盡一份心力。4 月 17 日先行報到，瞭解、熟悉論文發表會場簡報設備操作、動線、住宿飯店至論文發表地點-京都國際會議廳之交通及預估通勤時間(表 1)。4 月 18 日開幕式及專題演講後開始各主題領域論文發表。

表 1 議程表

IEEE ICASI 2024 International Conference on APPLIED SYSTEM INNOVATION

KYOTO, JAPAN, April 17-21, 2024

April 17-21, 2024, Kyoto, Japan. https://2024.icasi-conf.net

Conference Agenda

Venue: Kyoto International Conference Center **Language:** English

Pre-Conference Schedule		
Wednesday, April 17, 2024		
3:30 pm	5:30 pm	Early Conference Registration (Main Entrance, 1F)

Main-Conference Schedule		
Thursday, April 18, 2024		
8:20 am	9:00 am	Conference Registration and Conference Information Collection (Main Entrance, 1F)
9:00 am	9:30 am	Opening Ceremony (B-1, 2F)
9:30 am	9:40 am	Tea Break
9:30 am	12:00 am	Oral Session of A1, B1, C1, D1 (554, 555, 5F)
9:40 am	10:30 am	Keynote Speech 1 (B-1, 2F)
10:30 pm	10:40 am	Tea Break
10:40 am	11:30 am	Keynote Speech 2 (B-1, 2F)
11:30 am	1:00 pm	Free Time
1:00 pm	5:30 pm	Oral Session of A2-3, B2-3, C2-3, D2-3 (554, 555, 5F)
1:00 pm	2:30 pm	Poster Session of P1 (553, 5F)
2:30 pm	4:00 pm	Poster Session of P2 (553, 5F)
6:00 pm	8:00 pm	Conference Banquet (SAKURA, 1F)

1、開幕 Keynote Speech

開幕 Keynote Speech 邀請論文發表所在城市，京都大學教授兼任副校長、院長 Osamu Tabata 蒞臨專題演講，講題為「Micro and Nanotechnology to Bridge the Human Body and Machine(微奈米技術搭起人體及機械的橋樑)」(圖 1)。Osamu 教授是日本著名的微機電科技先驅，早期以創新開發與 CMOS（Complementary Metal-Oxide-Semiconductor，互補式金屬氧化物半導體）積體電路相容之 TMAH 非等向性腐蝕術（anisotropic etching）聞名於世，不但榮獲國際電機電子工程師協會及日本電機電子工程師協會等雙協會院士(IEEE Life Fellow, and IEEJ Fellow)，並且是全世界微機電會議 IEEE MEMS-2003 年 IEEE NEMS-2012 年之主辦人。演講內容主要為開發器官晶片(Organ-on-a-chip)應用於新藥研發領域。新藥研發從化學程序研發，藥劑對細胞反應的細胞培養皿試驗，動物試驗，床試驗至上市過程需耗費至少 9 年以上的時間、巨資與人物力，對開發單位將是漫長而且高度風險的投資。特別是傳統動物試驗模型往往不具人體生理條件的代表性，此動物試驗數據有時將誤導整個研發方向。為了降低人體試驗期間遭遇研發失敗的成本，需要發展心臟、肝臟、肺臟等器官晶片之微工程模型來改善人體藥物試驗前的預測效用。近年國內各大生醫體系也業競相投入器官晶片領域的研發，期能加速人類對抗疾病研發的速度。

圖 1 開幕 Keynote Speech

2、論文發表

個人論文發表編號 J240212C 安排於下午場次 Oral B2(554B 室)，表 2、圖 2)。題目為「A New ICT Architecture of Smart Water Network Platform for Improving Management Performance: Maintenance, Security, and Deployment Cost

」(新資訊架構供水監測平台改善管理效能:維護,安全及部署成本)。主要改善原因為本公司「供水監測平台」系統係早年由各區處開發建置自身特有的監控系統來記錄，管理管網的水壓、輸送水量及水質。由於各區處建置年份，資訊技術版本的差異，以及 各自系統不同的架構，各地區管理人員的監控系統遭遇到資訊點位故障排除、資訊安全維護困難、以及維護成本激增等問題。本論文針對上述缺點的解決方案，介紹了應用層面上建立了 改進策略流程，採用先進技術，例如開放平台通訊統一架 構（OPC UA）、工業閘道伺服器（IGS）、應用程式介接（API）、負載平衡、安全營運中心（SOC）等，將原有的分散式主機整合為集中式架構的單一新版本監控平台，輕鬆實現易維護、低更新成本、增強資訊安全部署的目標。改善後碳足跡以及部署成本分別為原系統架構的 35.47% 及 9.86%。實施結果展現改善後的集中式資訊系統在資訊 效率提高、維護方便、更新成本低廉等方面優於傳統的分散式架構。

本論文發表地點為日本京都國際會議廳係 1997 年制定「京都議定書」會議地點。論文發表期間向與會學者、同業宣揚與介紹本公司優化資訊系統及淨零排放的努力，與「京都議定書」淨零目標相契合。論文發表後受到多位學、業界先進的肯定、興趣與讚許，期望日後有交流與合作機會。本論文全文詳如附件及參考資料。接續至其他會場聆聽 AI 人工智慧領域論文。

表 2 論文發表場次表

IEEE ICASI 2024

International Conference on APPLIED SYSTEM INNOVATION

17-21 April 2024, Kyoto, Japan

iTiKi

Breakout Session of IEEE ICASI 2024 [Board Room: 554, 555, 5F] 9:30 am - 12:00 am, Thursday, April 18, 2024 (Japan Standard Time)			
Oral A1 (554A)	Oral B1 (554B)	Oral C1 (555A)	Oral D1 (555B)
J240172 IV4	J240062 A	J240003 C	J240013 D
J240179 IV4	J240064 A	J240007 C	J240026 D
J240180 IV4	J240067 A	J240018 C	J240037 D
J240217 IV4	J240235 A	J240028 C	J240040 D
J240237 IV4	J240280 A	J240032 C	J240044 D
J240291 IV4	J240492 A	J240043 C	J240048 D
J240302 IV4	J240065 B	J240077 C	J240069 D
J240437 IV4	J240087 B	J240092 C	J240070 D
J240012 A	J240091 B	J240143 C	J240074 D
J240034 A	J240164 B	J240219 C	J240078 D
J240035 A	J240333 B	J240246 C	J240089 D
J240139 K	J240396 B	J240534 C	J240101 D
J240141 K	J240458 B		J240133 D
J240142 K			
J240182 I			
Breakout Session of IEEE ICASI 2024 [Board Room: 554, 555, 5F] 1:00 pm - 3:00 pm, Thursday, April 18, 2024 (Japan Standard Time)			
Oral A2 (554A)	Oral B2 (554B)	Oral C2 (555A)	Oral D2 (MADF) (555B)
J240115 A	J240119 C	J240095 C	J240258 M
J240116 A	J240198 C	J240297 C	J240305 M
J240339 A	J240212 C	J240310 C	J240306 M
J240380 A	J240289 C	J240350 C	J240366 M
J240106 D	J240167 IV2	J240363 C	J240462 M
J240148 D	J240356 IV2	J240364 C	J240463 M
J240153 D	J240348 J	J240395 IV4	J240468 M

圖 2 論文發表

3、AI 人工智慧議題

IV3. Artificial Intelligent, Machine Learning, Deeping & Data Mining 人工智慧專論議題為 Invited Section 其中之一，共 10 餘位專家、學者發表 AI 人工智慧前瞻論文，顯示 AI 人人工智慧技術呈現爆炸性成長並且將對人類生活產生革命性的影響。論文名稱詳如表 3。聆聽 AI 人工智慧前瞻論文技術與方向後希望能激發台水公司產水技術的發想與精進以提升經營效能。例如編號 3「使用毫米波感測器預防人體工學危害的多任務深度學習方法」可運用在倉庫搬運物品的人體工學危害感測器，減少員工搬運物品的身體危害。編號 4「利用非匹配音訊距離損失提高 CMGAN（基於 Conformer 的 MetricGAN）在語音增強方面的效能」可提升手機語音辨識功能的精準度。編號 10「網路入侵偵測系統的增量學習模型」可強化網路駭客入侵的偵測速度。

表 3 人工智慧專論議題

序號	論文題目
1	Comparison and Investigation between VAE and VAE-GAN in Image Translation Tasks. (VAE 與 VAE-GAN 在影像轉換任務中的比較與研究)
2	Mechanism for Generating Predictive Masked Human Body Skeleton Based on generative AI. (基於生成式 AI 產生預測遮罩式人體骨骼機制)
3	Multi-task Deep Learning Approaches in Preventing Ergonomic Hazards using Millimeter-wave Sensors. (使用毫米波感測器預防人體工學危害的多任務深度學習方法)
4	IMPROVING THE PERFORMANCE OF CMGAN (Conformer based MetricGAN) IN SPEECH ENHANCEMENT WITH THE NON-MATCHING AUDIO DISTANCE LOSS.

	(利用非匹配音訊距離損失提高 CMGAN（基於 Conformer 的 MetricGAN）在語音增強方面的效能)
5	A Practical Approach to Integration Multi-Machine Data for Enhanced Quality Prediction in New Manufacturing Machines. (整合多機器資料以增強新製造機器品質預測的實用方法)
6	Application of Reinforcement Learning Models for Optimization of Air Traffic Control Protocols. (強化學習模型在空中交通管制協議最佳化的應用)
7	Enhanced Deep Learning Models Performance in 3D Multimodal Brain Tumor Segmentation with Garbar Filter. (使用 Garbar 濾波器增強深度學習模型在 3D 多模態腦腫瘤分割中的表現)
8	Research on Taxi Demand Prediction Based on Deep Learning and Multi-Types of Data. (基於深度學習和多類型數據的計程車需求預測研究)
9	Efficient Mining Weighted Flexible Periodic Patterns in Time Series Databases using a Period-based Algorithm with Multiple Join Policies. (使用具有多個連接策略的基於週期的演算法，有效挖掘時間序列資料庫中的加權靈活週期模式)
10	An Incremental Learning Model for Network Intrusion Detection Systems. (網路入侵偵測系統的增量學習模型)
11	Deep Neural Network for Aerial Image Dehazing. (用於航空影像去霧的深度神經網路)

4、參訪明神戶市石海峽大橋自來水設施

明石海峽大橋位於神戶市兵庫縣明石市銜接南方淡路島，1998 年通車後由原本從淡路島至本周耗時 40 分鐘定期通行船，縮短為 5 分鐘車程，不但大幅提升離島、偏鄉居民的生活品質，更打破與神戶本島之間的情感藩籬(圖 3、4)。

明石海峽大橋於西元 1988 年（昭和 63 年）5 月動工，歷時 10 年，耗資 5,000 多億日圓，於 1996 年（平成 8 年）9 月竣工，並在 1998 年（平成 10 年）4 月 5 日正式通車，其間經歷了 1995 年 1 月 17 日的阪神大地震的考驗。阪神大地震的震央距離橋址僅 4 公里，但大橋安然無恙，只在南岸的岸墩和錨錠裝置發生了輕微位移，使大橋的長度增加了約 1 公尺（大橋原設計長度為 3,910 公尺，主跨距 1,990 公尺），足以展示它通過當時 8.5 強震考驗的韌性。

圖 3 明石海峽大橋位置圖

明石海峽大橋全長 3,911 公尺，橋墩跨距 1,991 公尺，寬 35 公尺，兩邊跨距各為 960 公尺。在日本國內的人工構造物中，僅有東京晴空塔（634 公尺）、東京鐵塔（332.6 公尺）以及日本最高樓阿部野橋車站大樓（300 公尺）超過其橋塔高度。

明石海峽大橋橋面高度 65.72 公尺，設置 2 條直徑 450 毫米，長度 4.2 公里不銹鋼 SUS316 送水管，自神戶市神出淨水場(圖 4、5)輸送自來水至淡路島。神出淨水場海平面高度約 120 公尺，與橋面水管高度差 54.28 公尺，利用此水頭優勢足以重力流送水至淡路離島供水區，節能又環保。送水管登陸淡路島後設置調整池以釋放多餘水頭，經多段加壓及調整池組分送至南淡路島。

圖 4 明石海峽大橋及送水管

剛性不銹鋼送水管需考慮耐受日夜金屬管熱脹冷縮及地震期間橋面偏移的韌性及耐受海鹽侵蝕水管表面的能力。由圖 6 可知從淡路島遠眺神戶本島方向檢視送水管位於橋面右側，關西電力輸送線路位於橋面左側，二者水、火不容部署於橋面左右側，人員管理巡查行走通道置於橋面中央可兼顧左右線路。茲說明自來水設施特色如后[a]：

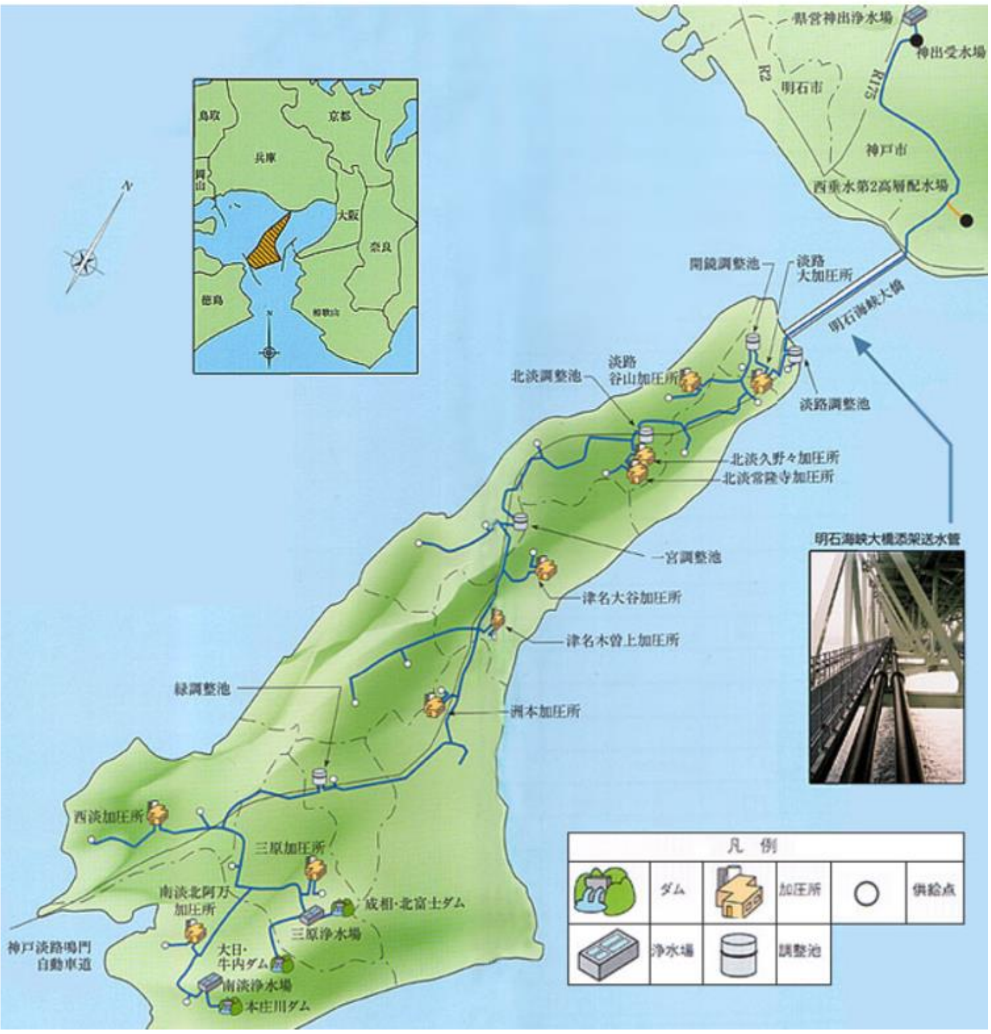

圖 5 明石海峽大橋自來水管圖

(1)、大型伸縮裝置

附掛的剛性水管必須具備跟隨橋梁位移的餘裕才不受橋樑軸線膨脹或縮縮的拉扯而鬆脫接頭。明石大橋軸向位移達正負 1,503 毫米，因此該伸縮管材質必須為高柔軟度、防止接頭脫落及輕巧的重量。

圖 7、8 為大型伸縮裝置結構圖，由符合「保持導管的連續性」、「具有較高的水密性」及「能夠應對反覆彎曲」功能的 4 組不銹鋼可橈管組

成的 U 型大型伸縮裝置施作於主塔二冊各 2 處，共 4 處，管底可移動伸縮。此外，為了平衡軟管的角位移量，按裝了受電弓，並且使用受電弓頂部的組合環支撐連接兩根水管，使每根水管以相同的方向移動。

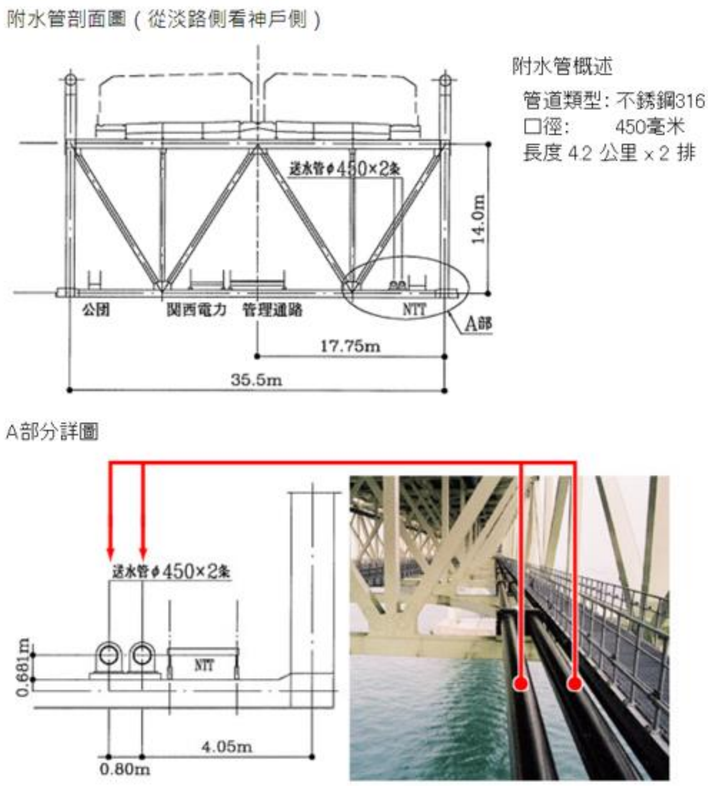

圖 6 送水管橋剖面圖

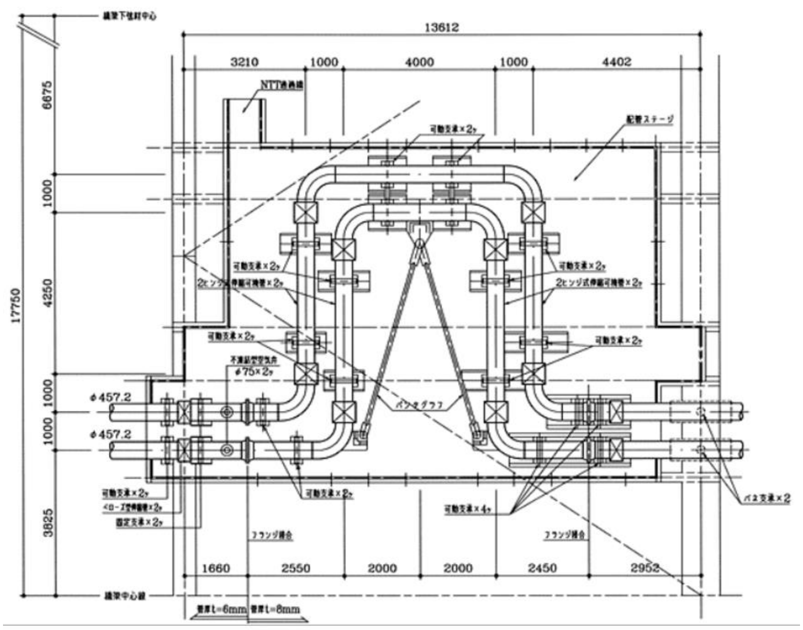

圖 7 大型伸縮裝置結構圖

圖 8 大型伸縮裝置現場照片

(2)、管體表面防腐

為避免不銹鋼送水管長年受到海水鹽分侵蝕而鏽蝕毀損及運送、固定管件等產生的刮痕，辦理了直管聚乙烯塗層，變形管段聚氨酯塗層及接頭段的熱收縮交聯聚乙烯管塗層(圖 9)。

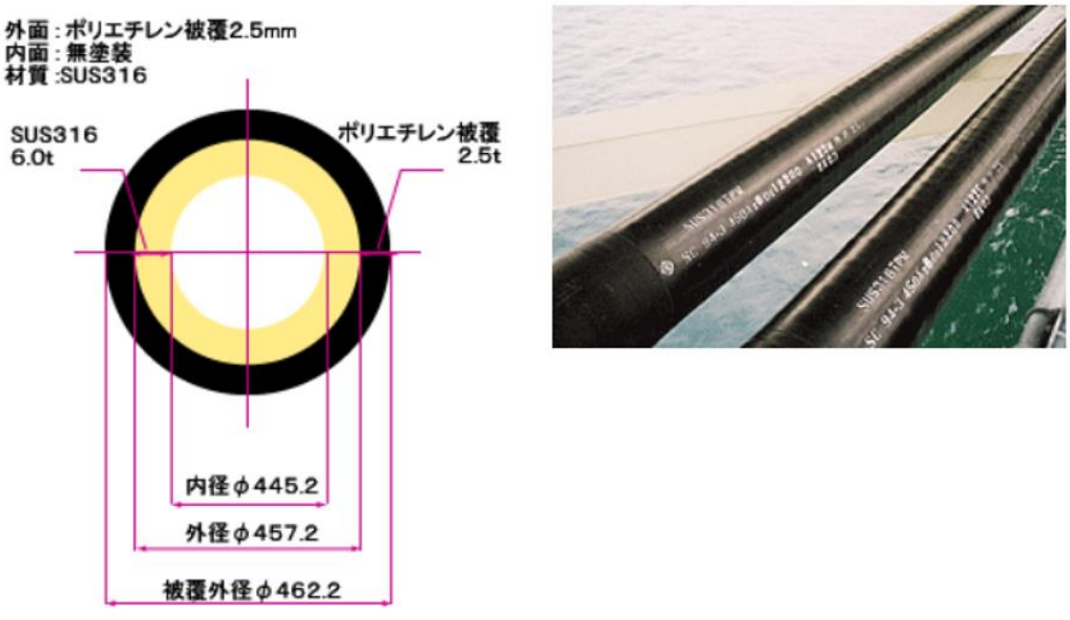

圖 9、管體表面防腐示意圖

(3)、淡路島供水模式

由圖 5 明石海峽大橋自來水管圖可知神出受水場供水至淡路後經淡路調整池釋放6公斤水頭高能量,由該調整池定壓穩定供給鄰近用戶,再經淡路大加壓所加壓至開鏡調整池定壓穩定供給鄰近用戶……,如此往復加壓送水至南淡路島應為考量該地區飽受地震侵襲之運用受水池高度之安全定壓供水作法。若以現今全世界正雷厲風行淨零排放觀點而言或可嚐試善用神出受水場 6 公斤水頭,旁路受水池輔以當地某地點合理參考水壓訊號回授控制減持壓閥內響導閥之定壓控制給該地區用戶以節省多段加壓供電成本。台水公司已將此調控模式成熟部署運轉於各管網關鍵點位。

三、心得及建議

AI 人工智慧可分為低於人類智慧的弱人工智慧、與人類智慧並駕齊驅的強人工智慧及超越人類智慧的超人工智慧。從幾十年前的 Fuzzy 溫控冷氣機、洗衣機等家電產品之專家系統,以權重判斷多處理模式路徑的類神經網路(Neural Network),到近年以多層類神經網路為底層判斷技術的打敗韓國世界棋王李世乭的 Google 公司 AlphaGo 及微軟公司 ChatGPT 生成式 AI 等皆屬於弱人工智慧領域,也只能處理有規則的事情。例如 AlphaGo 可快速記憶千萬盤的有規則圍棋棋譜搭配有圍棋能力的操作手協助重要關鍵點的指引就能超越人類的極限,但是遇到超出 ChatGPT 生成式 AI 能力範圍的需求也只能模糊帶過回應人類,才會有「一本正經的胡說」。

AI 人工智慧逐步朝向與人類思考能力同步的強人工智慧目標前進已不再是理論上的概念了。弱人工智慧領域階段以點狀運用各種領域,例如自駕車輔助系統逐漸應用於商業領域,致力於開發具體可行的技術和解決方案,來提升製程的效能等等,很快將運用到各面向領域。工業界已多面向嚐試運用 AI 這方面之技術但還未有明顯的突破,但是隨著護國神山-台積電公司突破摩爾定律的晶片處理效能一日千里的驚人速度將逐漸滲透至底層的 IOT 偵測設備以提升人工智慧 IOT 感知層反映時間及整體處理效能。台水公司已積極嚐試導入 AI 人工智慧於製程領域並且謹慎評估成效,未來可擴展應用其他先進技術。

1、數位雙生(Digital Twin)系統

工業 4.0 的技術應用數位雙生技術於模擬場域製造,規劃製程動線等等已逐步成為工業製造的一環。數位雙生的回饋源主要將製造場域各種感測器,如壓力、角度、速度感測器等訊號呈現於模擬數位場域。

個人編審並且發表於 106 年第 34 屆自來水研究發表會論文:「3D 動畫技術應用於自來水處理程序之研製」,結合暨有水力分析理論推導公式及淨水設備 3D 動畫,清楚、明確表達水力分析、公式於淨水設備之物理意義,讓初學者迅速了

解、吸收自來水淨水程序理論(圖 10)。本教學影片已成為湖山淨水場環境教育園區之環境教育課程並且已發佈於 You Tube 影片分享平台。本教學影片恰完成自來水淨水場的數位雙生場域的開發，只要加入各種感測器，如壓力、水質、抽水機角度、速度感測器等訊號呈現於模擬數位場域即達成數位雙生的研製。

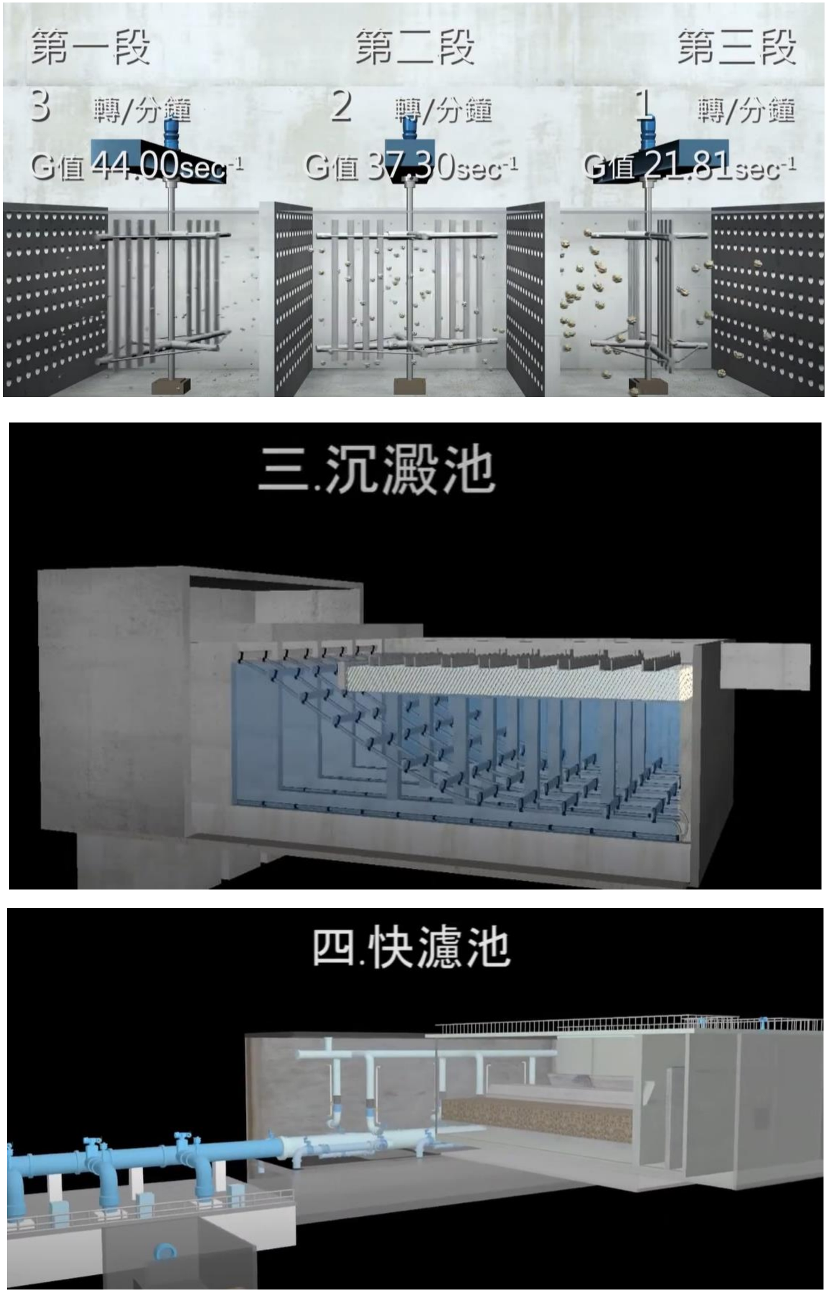

圖 10 3D 動畫技術應用於自來水處理程序之研製

2、Intelligent Status Diagnosis System for Water Circulation Device
(水循環設備的智慧健康診斷系統)

本論文利用人工智慧對水循環設備運作過程中的振動音頻進行分類，以確保設備的健康。本技術若能應用於抽水機的健康診斷，即時發出警報吊修，應能減少機修費的支出。

人工智慧的發展可謂一日三市，進步神速，相信「機械公敵」電影描述機器人融入人類生活的場景指日可待。希望透過本次論文發表的經驗，能激發出各式各樣的想法，不再侷限於各自的專業領域，而能積極地跨領域合作，碰撞出不一樣的火花，也期盼能藉由深入了解各國最前瞻之科技，創造出屬於我們自己的自來水製造技術，朝向淨零排放及永續發展的目標前進。

明石海峽大橋及附屬自來水管通過阪神大地震的考驗，其土建建造、應用不銹鋼可橈管及防腐技術強化剛性自來水管的彈性及韌性不但可為同為環太平洋地震帶的台灣工程學術、業界參考，而且提供網路預約申請參訪解說課程(圖 11)[b]，可為國人經常造訪日本關西地區深度旅遊的景點。

圖 11 明石海峽大橋網路預約申請參訪解說課程

四、附件及參考資料

1、論文發表全文

A new ICT architecture of smart water network platform for improving management performance: maintenance, security, and deployment cost

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Abstract

This paper introduces the application layer's solutions to the distributed servers, establishes improvement policy processes, and uses advanced technologies, such as Open Platform Communications Unified Architecture (OPC UA), Industrial Gateway Server (IGS), Application Programming Interface (API), etc., to integrate the original distributed hosts into a single new version monitoring platform with centralized architecture that is easy to achieve the goals of easy maintenance, low update cost and enhanced information security deployment. The carbon footprint and information deployment cost are only 35.47% and 9.86% of those before improvement respectively, making an important contribution to improving information efficiency.

Key words: Centralized architecture, OPC, IGS, Low update cost.

Introduction

In the early years, in order to quickly deploy and build a complete monitoring system at the beginning of construction, a large water company (water supply capacity 8.8x106 CMD, water user 1.835×10^{6}, delivery water network length 65,888 km) authorized each district manager to build their own unique monitoring system as shown in Fig. 1 to record and manage water pressure, delivery water volume and water quality in the water distribution networks. Due to differences in construction years, distinct information technology versions, and unlike architectures, monitoring systems in local district managers have encountered difficulties in troubleshooting information points, information security maintenance, and a surge in maintenance costs [1]. Each of these distributed hosts connected to the Internet is not only create multiple entrances for cyber-attacks, but also cannot reliably manage updates to all firewall versions. Furthermore, when computer software and hardware upgrade one generation every five to ten years, especially software security vulnerabilities are no longer updated, they must be replaced accordingly. The replacement cost and carbon footprint of N centralized architecture servers are nearly N times that of distributed host, as listed in Table 1. Upgrade cost and carbon footprint impose a heavy burden on the company's operating performance.

This article discusses the maintenance, security, and deployment cost issues of the existing information architecture, improvement strategies, simulation, implementation results and conclusions.

Problem Analysis and Improvement Approaches

Existing information systems have difficulties in inspecting and repairing fault signals caused by different architectures. Maintenance problems due to differences in OPC architecture, the security risks of cyber-attacks on send message block (SMC) data transmission methods and Internet entrances of internet of thing (IOT) devices, as shown in Figure 1. These vulnerability threat issues are discussed as follow.

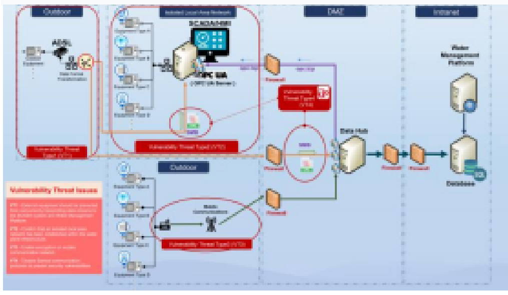

Fig. 1 Distributed water monitoring system.

A. *Vulnerability Threat in Internet*

Figure 1 shows that enterprises often use VPNs to prevent proprietary data from being exposed to the open Internet. Industrial control systems deploy a large number of programmable logic controllers (PLCs) to receive IOT signals from machines and centrally transmit them to the OPC UA server and human-machine interface SCADA in the control center. Data from enterprise's external IOT devices are usually transmitted to the system host through transmission methods such as ADSL or wireless communication. External IOT devices and wireless communications must also adopt VPN to strengthen security deployment. In addition, distributed hosts have their own Internet query platforms, which increases the difficulty of information security protection and the cost of host

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replacement.

B. Deployment Costs and Carbon Footprints

Table 1 is a comparison table of the deployment costs and carbon footprints of centralized and distributed hosts. A hyper-converged infrastructures composed of three physical machines is used for network domain, GIS map platform and data storage functions. Related software includes VM platform, VM server, OS licensing, and MS SQL. The number of N distributed hosts is N times that of the centralized hosts. The carbon footprint ratio and deployment cost ratio of centralized and distributed architectures are represented by (1) and (2) respectively:

Table 1 OPC-UA Client deploy cost and carbon footprint.

Server Architecture		Hardware		Software			Carbon Footprint Ratio (%)	Deploy Cost Ratio (%)
				Virtual Machine	Database			
		Infrastructure Host (500w)	Hyper Converged Infrastructure (800wx3)	1.VM Platform 2. VM Server 3. OS Licensing	SQL	SQL Express		
Deploy Cost (x10,000 USD)		0.3	4.69	4.8	4.3			(Nx0.3+4.69+4.8+4.3)/[Nx(4.69+4.8+4.3)] =9.86%, where N=13
Improved	Centralized	N	1	1	1	N	(Nx500+1800)/(Nx1800) =35.47%, where N=13	
Before Improvement	N Distribute		N					

$$\text{Carbon footprint } ratio = \frac{\text{Nx500+1800}}{\text{Nx1800}} x100 \qquad (1)$$

$$Deploy\ cost\ ratio = \frac{\text{N+0.3+4.69+4.8+4.3}}{N(4.69+4.8+4.3)} x100 \qquad (2)$$

The ratios of deployment costs and carbon footprints are one of the difference performance indicators for comparing centralized and distributed hosts. Both are the main indicators of the net-zero emissions issue, and they are one of the main targets for improvement in this article.

C. Improvement the Vulnerability Threat Issue

The analysis of the above issues can improvement the vulnerability threat issue in the industrial control and information fields of today's water companies, as shown in Figure 2.

VT1 - External equipment should be prevented from concurrently transmitting data streams to the SCADA system and Water Management Platform.

VT2 - Confirm that an isolated local area network has been established within the water plant infrastructure.

VT3 - Enable encryption on mobile communication network.

VT4 - Disable Samba communication protocols to prevent security vulnerabilities.

VT5 - Upgrade the iFix version with OPC UA functionality to reduce signal communication nodes.

VT6 - Replacing existing old distributed hosts with centralized hosts to significantly reduce deployment costs and facilitate maintenance. Isolate the Internet entrances of the original distributed hosts and change them to the Internet entrance of the centralized host at the enterprise headquarter to strengthen information security deployment.

D. Industrial Gateway Server (IGS)

This article advocates replacing distributed hosts in various places with centralized hosts at the corporate headquarters, and changing the two layers information architecture to the three layers information flow architecture [2]. From the perspective of the corporate headquarters, its branches manage manufacturing plants in multiple different locations. From the operational technology (OT) layer of the factory to the branches, and even the information technology (IT) layer of the corporate headquarters, information transmission at all levels plays a key role. The signal source of a large monitoring platform may come from IOT equipment dozens of kilometers away, and must be authorized to the local information vendors of the original distributed architecture to maintain the validity of the local signal. When a certain signal point on the monitoring platform fails, the centralized host manager must query where the fault point is. IGS can be serve as this critical vanguard in quickly locating signal faults, as shown in Figure 3.

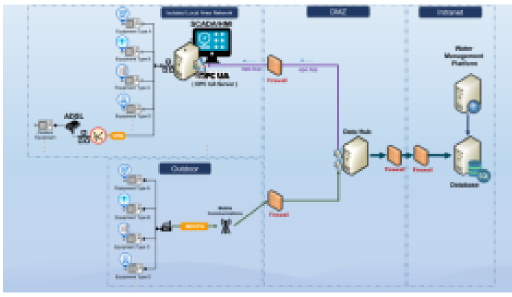

Fig. 2 Improvement the vulnerability threat issues.

IGS has the function of tagging name the signal source at the beginning of deployment. After receiving the PLC signal, IGS synchronously transmits the tag name to the HMI/SCADA of the OT layer and the OPC UA Client of the IT layer. IGS becomes the hub for signal transmission, and the administrator of the centralized host can find the fault location based on the tag name of the fault signal.

Fig.3 IGS transmission diagram.

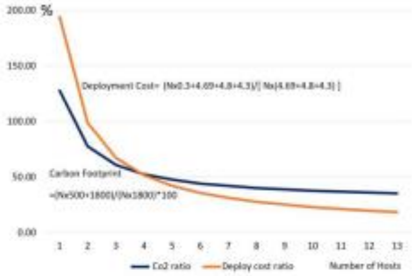

Fig. 4 Comparison chart of centralized host/distributed host.

Simulation and Improvement Results

Improving large-scale information systems requires funds, time and technology, especially when it comes to the transmission of industrial control signals. For a water company that is responsible for its own profits and losses, the update and improvement of investment equipment cannot affect the company's profits, it must be gradual and investment improvements must be made progressively. Figure 4 shows the deployment cost and carbon footprint simulation results between centralized hosts and decentralized hosts using (1) and (2). It shows that the ratio between the two forms a negative slope curve. The carbon footprint and information deployment costs of the centralized host are only 35.47% and 9.86% respectively of the distributed hosts where N=13. Figure 5 shows a screenshot of implement data at each layer when the water purification plant deploys IGS. From the water supply monitoring screen of top-layer IT, the OPC UA Client of middle-layer, the OPC UA of bottom-layer water purification plant and the corresponding signal management fields can all display 0.651 simultaneously. Managers of water supply monitoring system can use this mode to quickly and accurately check and repair fault points.

Conclusion

Existing distributed hosts face huge replacement costs, the difficulty of repairing multiple architectures, and the security risks of transmission methods will gradually improve. The expected carbon footprint and information deployment cost after the improvement are only 35.47% and 9.86% of those before the improvement, respectively. The results show that the improved centralized information system is better than the traditional distributed architecture in terms of improved information efficiency, convenient maintenance, and low update cost. The implementation results show that IGS is better than the traditional signal transmission architecture.

Fig.5 A screenshot of implement data at each layer when the water purification plant deploys IGS.

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