NONDESTRUCTIVE QUALITY EVALUATION

第十七屆農畜產品品質非破壞性檢測技術國際學術研討會

2024

October 29

Taiwan · Taipei

THE 17th INTERNATIONAL WORKSHOP ON NONDESTRUCTIVE QUALITY EVALUATION OF AGRICULTURAL, LIVESTOCK AND FISHERY PRODUCTS

National Taiwan University

Department of Biomechatronics Engineering, National Taiwan University
Taiwan Agricultural Mechanization Research & Development Center

第十七屆農畜產品品質非破壞性檢測技術國際學術研討會

The 17th International Workshop on Nondestructive Quality Evaluation of Agricultural, Livestock and Fishery Products

Organizers

Department of Biomechatronics Engineering, National Taiwan University

Taiwan Agricultural Mechanization Research & Development Center (TAMRDC)

Co-organizers

Chinese Institute of Agricultural Machinery, Taiwan

Taiwan Institute of Biological Mechatronics

Center for Intelligent Agriculture Education and Research, National Taiwan University

Bioenergy Research Center, National Taiwan University

Sponsoring Organization

College of Bioresources and Agriculture (CBA), National Taiwan University

National Taiwan University, Taipei, Taiwan

October 29, 2024

主辦單位

國立臺灣大學生物機電工程學系

財團法人農業機械化研究發展中心

協辦單位

中華農業機械學會

臺灣生物機電學會

國立臺灣大學智慧農業教學與研究發展中心

國立臺灣大學生物能源研究中心

補助單位

國立臺灣大學生物資源暨農學院

中華民國 113 年 10 月 29 日

國立臺灣大學鄭江樓 1F 信義講堂

Greetings

On behalf of the organizing committee, I would like to express my sincere gratitude to all the participants of the 17th International Workshop on Nondestructive Quality Evaluation of Agricultural, Livestock, and Fishery Products (a.k.a. Nondestructive Workshop). The Nondestructive Workshop has been a pillar of innovation and collaboration in the realm of nondestructive quality assessment since its inception in 2005. Throughout its history, the workshop has achieved remarkable milestones, serving as a vital platform for the exchange of pioneering research, insights, and technologies. It has facilitated knowledge sharing, sparked insightful discussions, and forged enduring partnerships, all of which have played a pivotal role in the growth and sustainability of these essential sectors.

The program of the 17th Nondestructive workshop is filled with illuminating presentations that promise to ignite your curiosity and inspire innovative thinking. Topics spanning digital phenotyping, circular bioeconomy, and next-generation food systems are explored by esteemed experts in their respective fields. Many emerging technologies such as machine vision, artificial intelligence, unmanned aerial vehicle are included in the presentations. Speakers from The United States, Japan, Spain, and Taiwan join us. The audience expects to be around 150. We extend a warm welcome to all participants, both near and far, who join us for this momentous occasion. Our sincere gratitude goes out to the sponsoring organizations for their unwavering support, dedication, and tireless efforts in making this workshop a reality.

As we embark on this journey of exploration, collaboration, and discovery, let us keep in mind the profound impact we can collectively make in agriculture. Together, we can shape a future where nondestructive quality evaluation technology leads the way towards innovative, efficient, and resilient practices.

Yan-Fu Kuo, Ph.D.
Organizer of the Workshop
Professor, National Taiwan University

議程表

時間	內容	主持人 / 演講者
08:30 - 09:00	報到	吳筱梅 教授 國立臺灣大學
09:00 - 09:10	開幕式	生物資源暨農學院 林裕彬 院長 生物機電工程學系 盧福明 名譽教授 生物機電工程學系 郭彥甫 教授 農業機械化研究發展中心 邱奕志 主任
	第一節	梁辰瑋 教授 國立宜蘭大學
09:10 - 09:50	農業的數位轉型：促進生產力邁向循環生物經濟 The Digital Transformation of Agriculture: Advancing Productivity Towards a Circular Bioeconomy	John F. Reid 教授 美國伊利諾大學香檳分校
09:50 - 10:20	利用 AI 技術於無人機影像之作物監測 Crop Monitoring Using AI Technology on UAV Images	楊明德 院長 國立中興大學
10:20 - 10:50	茶歇	
	第二節	朱玟霖 教授 國立中興大學
10:50 - 11:30	利用以使用者為中心的人工智慧表型分析達成永續農業生產 Advancing Sustainable Food Production through User-Centric AI-Based Phenotyping	Wei Guo 教授 日本東京大學
11:30 - 12:00	利用光譜和深度學習技術對番茄早期乾旱生理狀態的非破壞性檢測 Non-destructive Detection for the Early Drought Stress Status of Tomato (*Solanum lycopersicum*) by Spectroscopy and Deep Learning	杜元凱 博士 農業部農業試驗所
12:00 - 13:30	午宴	
	第三節	李文宗 教授 國立屏東科技大學
13:30 - 14:10	農業機器人的表型體分析策略：大量採樣與即時水果評估 Phenotyping Strategies for Agricultural Robots: Massive Sampling and Real-time Fruit Assessment	Francisco Rovira-Más 教授 西班牙瓦倫西亞理工大學
14:10 - 14:40	應用 AI 於影像與光譜技術：掌握作物生長到風味分析 AI-Powered Imaging and Spectral Techniques: From Crop Growth Monitoring to Flavor Analysis	陳世芳 教授 國立臺灣大學
14:40 - 15:10	茶歇	
	第四節	龔毅 教授 國立嘉義大學
15:10 - 15:50	智慧農業：需求、挑戰與應對策略 Smart Agriculture, the Needs, Challenges and Approaches	Qin Zhang 教授 美國華盛頓州立大學
15:50 - 16:20	影像紋理特徵分布在農田類型分類中的應用 Application of Image Texture Feature Distribution on Agriculture Field Type Classification	劉力瑜 教授 國立臺灣大學
16:20 - 17:00	綜合討論 John F. Reid 教授 美國伊利諾大學香檳分校 Qin Zhang 教授 美國華盛頓州立大學 Wei Guo 教授 日本東京大學 Francisco Rovira-Más 教授 西班牙瓦倫西亞理工大學 林達德 教授 國立臺灣大學 楊明德 院長 國立中興大學 劉力瑜 教授 國立臺灣大學 杜元凱 博士 農業部農業試驗所 陳世芳 教授 國立臺灣大學 梁辰瑋 教授 國立宜蘭大學 李文宗 教授 國立屏東科技大學 朱玟霖 教授 國立中興大學 龔毅 教授 國立嘉義大學	盧福明 名譽教授 國立臺灣大學

PROGRAM

Time	Agenda	Chair / Speaker
08:30 - 09:00	Registration	Prof. Hsiao-Mei Wu National Taiwan University
09:00 - 09:10	Opening Ceremony	Prof. Yu-Pin Lin (Dean of CBA) Prof. Emeritus Fu-Ming Lu Prof. Yan-Fu Kuo Prof. Yi-Chich Chiu (Director of TAMRDC)
	Session I	Prof. Chen-Wei Liang National Ilan University
09:10 - 09:50	The Digital Transformation of Agriculture: Advancing Productivity Towards a Circular Bioeconomy	Prof. John F. Reid Univ. of Illinois at Urbana-Champaign
09:50 - 10:20	Crop Monitoring Using AI Technology on UAV Images	Prof. Ming-Der Yang (Dean of CE) National Chung Hsing University
10:20 - 10:50	Coffee Break	
	Session II	Prof. Wen-Lin Chu National Chung Hsing University
10:50 - 11:30	Advancing Sustainable Food Production through User-centric AI-based Phenotyping	Prof. Wei Guo The University of Tokyo
11:30 - 12:00	Non-destructive Detection for the Early Drought Stress Status of Tomato (*Solanum lycopersicum*) by Spectroscopy and Deep Learning	Dr. Yuan-Kai Tu Taiwan Agricultural Research Institute
12:00 - 13:30	Lunch Break	
	Session III	Prof. Wen-Tzong Lee National Pingtung Univ. of Sci. and Tech.
13:30 - 14:10	Phenotyping Strategies for Agricultural Robots: Massive Sampling and Real-time Fruit Assessment	Prof. Francisco Rovira-Más Polytechnic University of Valencia
14:10 - 14:40	Application of Image Texture Feature Distribution on Agriculture Field Type Classification	Prof. Shih-Fang Chen National Taiwan University
14:40 - 15:10	Coffee Break	
	Session IV	Prof. Yi Kung National Chiayi University
15:10 - 15:50	Smart Agriculture, The Needs, Challenges and Approaches	Prof. Qin Zhang Washington State University
15:50 - 16:20	Application of Image Texture Feature Distribution on Agriculture Field Type Classification	Prof. Li-yu Daisy Liu National Taiwan University
16:20 - 17:00	General Discussion <u>Panelists</u> Prof. Ta-Te Lin — National Taiwan University Prof. John F. Reid — University of Illinois at Urbana-Champaign Prof. Ming-Der Yang — National Chung Hsing University (Dean of CE) Prof. Chen-Wei Liang — National Ilan University Prof. Li-yu Daisy Liu — National Taiwan University Prof. Wei Guo — The University of Tokyo Prof. Francisco Rovira-Más — Polytechnic University of Valencia Prof. Wen-Lin Chu — National Chung Hsing University Dr. Yuan-Kai Tu — Taiwan Agricultural Research Institute Prof. Shih-Fang Chen — National Taiwan University Prof. Wen-Tzong Lee — National Pingtung Univ. of Science and Technology Prof. Qin Zhang — Washington State University Prof. Yi Kung — National Chiayi University	Prof. Emeritus Fu-Ming Lu National Taiwan University

The Digital Transformation of Agriculture: Advancing Productivity Towards a Circular Bioeconomy

Abstract

Over the past 150 years, agriculture has witnessed a significant shift with the mechanization of machine systems aimed at enhancing productivity and convenience. The advent of precision agriculture technologies since the 1990s has acted as a pivotal point, gradually evolving into a catalyst for smart agriculture and further improving production practices. The integration of machine electronics, automation, precision guidance, communication, and cloud computing has not only increased machine productivity but also brought about notable enhancements in worksite productivity. Presently, autonomous machine systems are emerging as the next frontier, offering diverse pathways for future productivity and convenience while addressing the pressing need for sustainability and decarbonization. This presentation will review the fundamental aspects of digital technologies that currently deliver value in agriculture and explore the research opportunities lying ahead in the journey from automation to autonomy of large-scale production systems. The focus will be on how these advancements contribute to the creation of a circular bioeconomy. By leveraging digital transformation, the agriculture sector can foster sustainable practices, optimize resource utilization, and enhance overall productivity, paving the way for a more circular and environmentally conscious future.

Professor John F. Reid

Executive Director, Center for Digital Agriculture
University of Illinois at Urbana-Champaign

RESEARCH AREAS AND EXPERTISE

- Translation of research into practice, outcome-driven innovation processes, business model innovation, and innovation management.
- Circular bioeconomy in agriculture, precision agriculture technologies, agricultural robotics and automation, automation of agricultural and biological systems.
- Deployment of embodied AI in agriculture, construction, and marine application verticals.

SELECTED AWARDS AND RECOGNITION

- Fellow, International Academy of Agricultural and Biosystems Engineering (2024)
- National Academy of Engineering (2019)
- John Deere Fellow (2017)
- ASABE Fellow (2004)

Dr. Reid has more than 35 years of highly accomplished technology leadership experience in industry and academia. From 1986-2000, he served on the faculty and achieved the rank of Professor at the University of Illinois where his research focused on sensing, automation, and control of food and agricultural systems.

Dr. Reid then spent 19 years with Deere and Company where initiated the development of enterprise field robotics capabilities. He has experience in innovation management having served as John Deere's Director, Enterprise Product Innovation and Technology for 14 years. In 2017 he was recognized as John Deere Technical Fellow for his contributions in Technology Innovation.

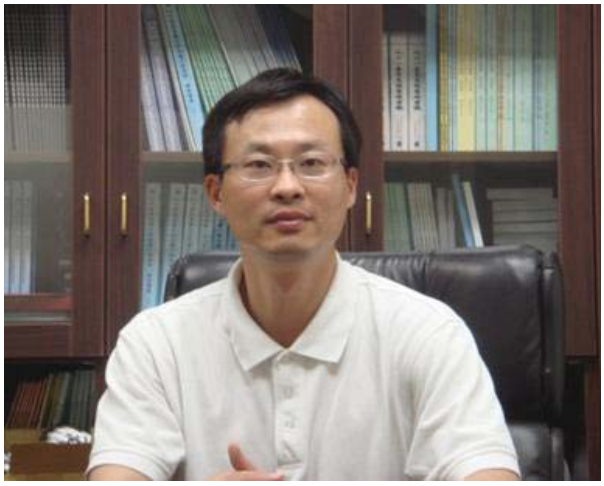
From 2020-2022, he was Vice President of Enterprise Technologies for Brunswick Corporation and responsible for building organizational capabilities that enabled initial products in vessel electrification and autonomy. In 2019, he was elected to the National Academy of Engineering for contributions to automation in agriculture.

In 2022, Dr. Reid returned to academia at the University of Illinois in Urbana-Champaign where he is a research faculty member with joint appointments in CS, Ag and Bio Engineering, and Electrical and Computer Engineering. He also is the Executive Director of the NCSA Center for Digital Agriculture.

Crop Monitoring Using AI Technology on UAV Images

Abstract

Remote sensing technology has been extensively applied in agriculture. In particular, the application of unmanned aerial vehicles (UAVs) to acquire high-resolution images has become a new trend in precision farming. Compared with satellite imagery, which is subject to the satellite's repeat cycle, and aerial photography, which is costly, UAV imagery presents the advantages of high speed, convenience, and low cost, which makes it ideal for the short-term monitoring of plant growth. Because the low flight height of UAVs helps obtain images of objects in the scale of millimeters, UAV imagery has been successfully used in crop classification, weed detection, and growth monitoring, indicating its feasibility for use in in precision farming. However, a large amount of UAV images needs an efficient image process technology. With the advances in AI (Artificial Intelligence) technology, deep learning with high performance computation have been extensively used in image recognition. The presentation demonstrates the application of AI technology to UAV images in precision agriculture, especially large-area rice lodging identification. Furthermore, by combining autonomous scouting and lodging rice detection with edge computing, it is possible to estimate rice lodging by flying at a high altitude for broad scan and then at a low altitude for precise identification in one flight mission. In the future, AI identification on UAV images will provide a great opportunity to identify crop growth and field anomalies over a broad area and even in real-time for precision agriculture.



Ming-Der Yang

Distinguished Professor & Dean, Department of Civil Engineering

National Chung Hsing University

RESEARCH AREAS AND EXPERTISE

- General area: Geomatics and Remote Sensing
- Specific area: Image Processing, Geographic Information Systems (GIS), Environmental Monitoring, Disaster Assessment, and AI Applications in Remote Sensing

SELECTED AWARDS AND RECOGNITION

- Tech Breakthrough Award (2019, 2020, 2022, and 2023)
- Outstanding Research Award (2021)
- Third Potential Investment Prize at International Forum and Exhibition for AI Innovation Research Center Program (2019)

Ming-Der Yang received his B.S. degree in Civil Engineering from National Chiao Tung University, Taiwan, in 1990, and M.S. and Ph.D. degrees in 1993 and 1996, respectively, from Department of Civil and Environmental Engineering and Geodetic Science, The Ohio State University, USA. He is presently a Distinguished Professor in the Department of Civil Engineering, National Chung Hsing University, and serves the Dean of College of Engineering. His expertise is geomatics and remote sensing, especially in image processing, geographic information system, environmental monitoring, and disaster assessment. He has authored about 100 international journal/conference publications. In addition, he is also granted patents on a street panoramic image preview system and gesture control. Recently, his research efforts have been put on developing Artificial Intelligence on remote sensing images for agricultural monitoring and disaster assessment. His Recent research effort has been put into 3D scene reconstruction, the applications of VR/AR and AI. Recently, he applied AI technology to UAV images for precision agriculture, and has been awarded many prizes, such as Tech Breakthrough Award in 2019, 2020, 2022, and 2023, respectively. He was also awarded Outstanding Research Award in 2021 and the Third Potential Investment Prize at International Forum and Exhibition for AI Innovation Research Center Program in 2019.

Advancing Sustainable Food Production through User-Centric AI-Based Phenotyping

Abstract

The integration of artificial intelligence (AI) into sustainable agriculture has revolutionized phenotyping, the process of measuring and analyzing plants and their surrounding ecosystems. User-centric AI-based phenotyping focuses on developing tools and systems tailored to the needs of farmers, breeders, agronomists, researchers, and agricultural stakeholders. These AI systems leverage machine learning algorithms and advanced image-sensing techniques to provide accurate, real-time data on crop health, growth patterns, and environmental interactions. This presentation will introduce the current research activities of the Laboratory of Field Phenomics at the University of Tokyo.

Associate Professor Wei Guo

Graduate School of Agricultural and Life Sciences
The University of Tokyo

RESEARCH AREAS AND EXPERTISE

- General area: Agricultural Informatics
- Specific area: Plant Phenomics, Machine learning and Image processing

SELECTED AWARDS AND RECOGNITION

- Senior Editor, Plant Phenomics, 2023-
- Board Member, Councilor of Japanese Society of Agricultural Informatics.
- Board Member, Japanese Plant Phenotyping Network.
- JSAI Shinnourin International Award, by Japanese Society of Agricultural Informatics. To: Guo, W. 2022.05.
- Young Researcher's Award, by Japanese Society of Agricultural Informatics. To: Guo, W. 2020.05.
- Best presentation award, at 136th Meeting of the Japanese Society of Breeding. To: Guo, et al., 2019.09.
- Director Award, at 2018 AIP Challenge Program by AIP Network Laboratory, JST (Japan Science and Technology Agency). To: Guo, W. 2019.04.

Wei Guo, Ph.D., is an Associate Professor and PI at the Laboratory of Field Phenomics, Graduate School of Agricultural and Life Sciences, the University of Tokyo, Japan. Trained as an engineer in computer science/informatics in China and Japan, he received his Ph.D. in agriculture, majoring in agro-informatics at the University of Tokyo in 2014. He established the “Laboratory of Field Phenomics,” Japan's first plant phenomics laboratory, as a core member in 2017. His research focuses on field-based phenotyping using advanced sensing platforms and technologies such as drones and ground robots, image processing, and machine learning approaches. In 2020, Guo received the Young Researcher’s Award from the Japanese Society of Agricultural Informatics. He has published over sixty journal papers in the field of plant phenomics. His synergistic activities include being a Board member of “Japanese Society of Agricultural Informatics(JSAI)”; International Commission of Agricultural Engineering (CIGR) “Technical Section VII (IT)” and “WG12 - Artificial Intelligence and Data Science”; “Japanese Plant Phenotyping Network”. He is also the Senior editor of the journal “Plant Phenomics”.

Non-destructive Detection for the Early Drought Stress Status of Tomato (*Solanum lycopersicum*) by Spectroscopy and Deep Learning

Abstract

This study introduces a deep learning architecture termed 1D-SP-GC Net, designed to analyze Vis/NIR (visible to near-infrared) spectoscopic data obtained from the canopy leaves of tomato plants (*Solanum lycopersicum*). The 1D-SP-GC Net was employed to develop a non-destructive model for detecting early drought physiological status in tomatoes. Compared to commonly used models for spectral data analysis, such as Partial Least Squares (PLS) regression, Random Forest (RF), and Convolutional Neural Networks (CNN), the 1D-SP-GC Net demonstrated superior prediction accuracy (>95%). Additionally, by utilizing Gradient-weighted Class Activation Mapping (Grad-CAM) within the 1D-SP-GC Net architecture, the study identified specific spectral bands that significantly contributed to the model's discriminative capability. The 1D-SP-GC Net effectively detected early drought conditions in tomato plants, offering a timely warning system for farmers to implement appropriate agricultural practices, thereby mitigating the impact of drought stress on the quality and yield of tomatoes.

Associate researcher, Yuan-Kai Tu

Crop Genetic Resource and Biotechnology Division
Taiwan Agricultural Research Institute

RESEARCH AREAS AND EXPERTISE

- General area: Biochemistry and Biostatistics
- Specific area: Plant phenotyping

SCIENTIFIC ACTIVITY

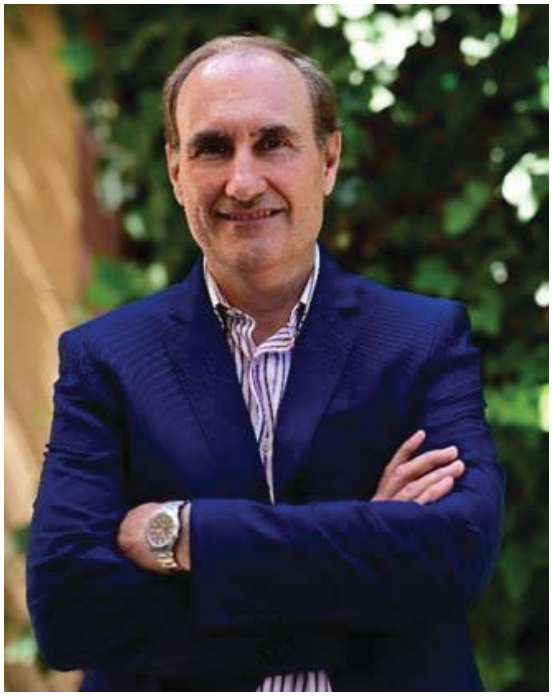
- 2023: Summer School on Image Analysis for Plant Phenotyping. Wageningen University and Research. Nederland.
- 2018: Visiting Scholar. Australian Plant Phenomics Facility (APPF). Australia.
- 2017: Machine Learning for Big Visual Data. IEEE International Elite School. Taiwan.

Yuan-Kai Tu earned his Bachelor's degree in Natural Science Education from the University of Taipei, Master's degree in Biochemistry from National Taiwan University, and Ph.D. in Agronomy from National Chung Hsing University, Taiwan. He commenced his research career at the Genetic Resources and Biotechnology Division of the Agricultural Research Institute (TARI). With a strong foundation in biochemistry and biostatistics, Dr. Tu specializes in applying advanced quantitative methods to plant genotyping and phenotyping analyses. His research endeavors aim to elucidate the correlations within biological data. In addition to his research activities, Dr. Tu is actively involved in the strategic planning and development of phenomics research initiatives at TARI.

Phenotyping Strategies for Agricultural Robots: Massive Sampling and Real-time Fruit Assessment

Abstract

Artificial intelligence has the capability of setting an alliance with farmer knowledge to get further away by letting computers do what they excel at, and by keeping farmers doing what they can do best. The VineScout (2017-2020) and Cerberus (2024-2027) projects are EU-funded grants that use ground robots for automating data collection as a systematic way of approaching big-data conditions, and thus facilitating the application of AI algorithms that heavily rely on data. The former robot modeled water stress as a phenotype-derived quality indicator for assessing the potential of grapes to get a great wine that required large amounts of data. Massive sampling with the robot let us move from less than 50 manual samples per hectare to over 20,000 measuring points per hectare. This talk will discuss the result of this AI-based classification strategy and the opportunities that robotic harvesting offers to map and assess quality properties in high-value crops. The challenge for competitive wineries and fruit producers for the fresh market is how to keep up to the consumer expectations under the climatic uncertainties being faced today.



Professor Francisco Rovira-Más

Agricultural Robotics Laboratory

Polytechnic University of Valencia (Spain)

RESEARCH AREAS AND EXPERTISE

- General area: Digital agriculture
- Specific area: Robotics, precision farming, automation
- Robotics view: doi.org/10.1007/978-3-030-89123-7_147-2

SELECTED AWARDS AND RECOGNITION

- 6 US patents and 1 EU patent granted
- 4 ASABE paper awards
- Edmund Optics Research & Innovation Award (2011)

Francisco Rovira-Más received a degree in Agricultural Engineering in 1996 from the Universitat Politècnica de València, Spain, where he was an Assistant Professor from 1997 to 2000. He obtained his Ph.D. in 2003 in the University of Illinois at Urbana-Champaign, Urbana, IL, USA. He has been a member of the Intelligent Vehicles System group at the John Deere Technology Center in Moline, IL, USA. He has also been a Research Associate with the Department of Agricultural and Biological Engineering in the University of Illinois, conducting research at the John Deere Intelligent Vehicle Systems unit (formerly Agricultural Management Solutions --AMS) in Urbandale, IA, USA. Currently, Francisco is a Professor at the Universitat Politècnica de València in Spain and director of the Agricultural Robotics Laboratory. His research interests include autonomous vehicles, machine vision, controls, off-road equipment automation, robotics, and artificial intelligence. Francisco has been the technical manager of the European project VineRobot and the coordinator of the EU H2020 FTI project VineScout. At present, he is the coordinator of project Cerberus, funded with 4.8 M€ and involving 13 institutions from Slovenia, Italy, Cyprus, and Spain.

AI-Powered Imaging and Spectral Techniques: From Crop Growth Monitoring to Flavor Analysis

Abstract

In crop production, harvesting, and post-harvest handling, traditional methods heavily rely on human labor for monitoring, recording, and decision-making. However, the growing shortage of experts and the decline in available labor present significant challenges. By integrating IoT sensors, autonomous vehicles, image processing, spectral sensing, and AI algorithms, expert decision-making processes can be emulated. This presentation will explore how these advanced technologies have the potential to significantly enhance agricultural practices. Examples such as tomato, tea, and coffee will illustrate the application of deep learning in crop growth monitoring, pest and disease identification, harvest prediction, and even market-level quality grading and flavor prediction of beverages. These innovations not only offer more efficient and labor-saving field management practices but also provide groundbreaking insights into food flavor science.

Associate Professor Shih-Fang Chen

Department of Biomechatronics Engineering
National Taiwan University

RESEARCH AREAS AND EXPERTISE

- General area: Precision Agriculture and Quality Control
- Specific area: Machine Vision and Spectral Sensing

SELECTED AWARDS AND RECOGNITION

- Excellent Teaching Award, National Taiwan University, 2018, 2019, and 2024
- Associate Editor, Engineering in Agriculture, Environment and Food, 2023-
- Third Place, 2021 CTCI Foundation AI Innovation Competition, 2021
- National Agricultural Science Award, Ministry of Agriculture, 2019

Shih-Fang Chen is an Associate Professor in the Department of Biomechatronics Engineering from National Taiwan University (NTU). She received her Bachelor and Master's degrees in Bio-Industrial Mechatronics Engineering at NTU, and Ph.D. degree in Agricultural and Biological Engineering from the University of Illinois at Urbana-Champaign, USA. Shih-Fang's research focuses on applying image processing and spectral techniques in plant status monitoring and agricultural product quality evaluation. She is dedicated to advancing smart agriculture by integrating Internet of Things (IoT) and Artificial Intelligence (AI) technologies to enhance precision farming practices. She has worked on a variety of projects, including plant disease identification, harvest time prediction, agricultural product grading, pesticide residue detection, and flavor prediction. She served as a Guest Editor for Special Issues of Computer and Electronics in Agriculture and currently serves as one of the Associate Editors for Engineering in Agriculture, Environment and Food. She is also the leader of the research group at the Center for Intelligent Agriculture (CIA) Education and Research at NTU.

Smart Agriculture, the Needs, Challenges and Approaches

Abstract

The extensive use of EIC technologies, especially AI and digital technologies, in agriculture, people believe that the industry is now moving to a new era of “smart agriculture”. While researchers put great enthusiasm to adopt AI & digital technologies in solving agricultural problems, people are still unsure what is the core issue they are going to address. The speaker suggests as a new era of technology advancement, smart agriculture should target on improving the capability of sustainably produce differentiated quality food to meet the needs of different customers, i.e. higher the overall efficiency on agri-food production, just like precision agriculture being targeting on optimizing the use of resources, mechanized agriculture on higher productivity, and cultivated agriculture on producing sufficient food. The adoption of EIC technologies provides the needed means to address this challenge.

Qin Zhang

Professor Emeritus, Biological Systems Engineering
Washington State University

RESEARCH AREAS AND EXPERTISE

- General area: Agricultural Machinery Automation and Agriculture Automation
- Specific area: Automated and Autonomous Agricultural Machinery Technologies, Intelligent Agricultural Machinery Controls, On-Machinery Crop Health Sensing Technologies, Machinery-Area Network Technologies, Agricultural Infotronics Technologies

SELECTED AWARDS AND RECOGNITION

- John Deere Gold Medal (2017)
- iAABE Fellow
- ASABE Fellow
- Member, Washington State Academy of Science (WSAS)
- Honorary Vice President, International Commission of Agricultural and Biological Engineering (CIGR)
- Full Member, Club of Bologna (World Taskforce on Agricultural Mechanization Strategies)
- Former Director, Center for Precision and Automated Agricultural Systems (CPAAS), WSU

Dr. Qin Zhang is the former Director of the Center for Precision and Automated Agricultural Systems (CPAAS) and a Professor Emeritus of Biological Systems Engineering, Washington State University (WSU); a Member of Washington State Academy of Science (WSAS), a Fellow of iAABE (International Academy of Agricultural and Biological Engineering) and ASABE. He has received several awards and honors over his career, featured by John Deere Gold Medal in 2017. Dr. Qin Zhang has given 20 keynote speeches and 37 invited talks at international professional conferences, plus numerous invited seminars and guest lectures at 60+ universities Worldwide. He has also been invited to give talks at more than a dozen major agricultural equipment manufacturers in North/South America, Europe, and Asia. Dr. Qin Zhang is an Honorary Vice President of CIGR (International Commission of Agricultural and Biological Engineering), a Full Member of the Club of Bologna (a World Taskforce on the Strategies for the Development of Agricultural Mechanization).

Application of Image Texture Feature Distribution on Agriculture Field Type Classification

Abstract

Identifying farmland use has long been crucial in large-scale agricultural production management. This study utilized multi-temporal visible RGB images, captured by UAVs over agricultural areas in Taiwan, to develop a model for classifying field types. We combined color and texture features to extract more information from the RGB images. Instead of the common Haralick feature, we employed the vectorized gray-level co-occurrence matrix (GLCMv) as the texture feature to enhance classification accuracy. The Extreme Gradient Boosting (XGBoost) algorithm was selected to build the classifier. The results showed that the highest overall accuracy reached 82%, and the best balanced accuracy across categories reached 97%. Our comparison revealed that color features provide the most information for the classification model and yield the most accurate classifier. When combined with GLCMv, accuracy improved by about 3%. In contrast, the Haralick feature did not enhance accuracy, indicating that GLCMv contains more useful information for prediction.

Professor Li-yu Daisy Liu

Department of Agronomy

National Taiwan University

RESEARCH AREAS AND EXPERTISE

- General area: Agricultural Statistics
- Specific area: Image analyses; crop modeling

SELECTED AWARDS AND RECOGNITION

- Outstanding Teaching Award, National Taiwan University, 2019

Li-yu Daisy Liu is a Professor in the Department of Agronomy at National Taiwan University (NTU). She received her Bachelor and Master's degrees in Agronomy at NTU, and Ph.D. degree in Department of Statistics at Texas A&M University, Texas, U.S.A. After graduation from Texas A&M University, she became an Assistant Professor at NTU in 2005. Her recent research topic is data analysis applied to the agricultural science collaborated with colleagues in other disciplines. Recent publications include the study of expression mechanism of insect resistance genes (Cheah et al., 2020), the coconut rhinoceros beetle transcripts (Shelomi et al., 2019), and molecular marker development of rice blast resistance (Chen et al., 2021), the application of avian influenza virus sequences to explore transmission routes (Yang et al., 2020), UAV image recognition and analysis tools (Liao et al., 2021 ; Lee et al., 2024), and image recognition and analysis tools for lawn mowing robots (research in progress), etc.

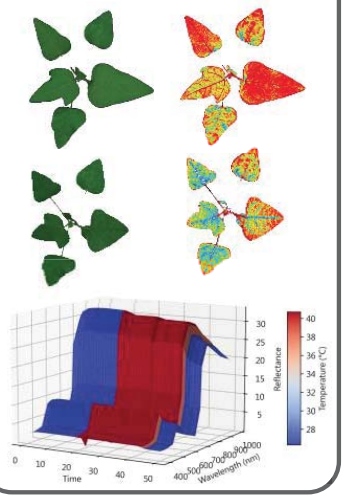
HiPoint Phenotyping 植物活體表型分析系統

The Phenotron PH300 the world's first 3D multispectral imaging analysis system for plant phenotyping research, featuring an automatic environmental control system. Developed by HiPoint, it enables long-term plant monitoring for breeding, quality control, and AI models for stress and disease analysis. Its advanced software automates data recording and environmental control, offering precise solutions for phenotyping, stress, and breeding research.

Phenotron PH300 是全球首款針對作物表型研究設計的環控影像設備，具自動環控系統及3D多光譜影像模組，可長期監測植物表型變化，應用於育種、品質檢測及AI模型建置，並提供高效的植物生長與環境適應性研究解決方案。

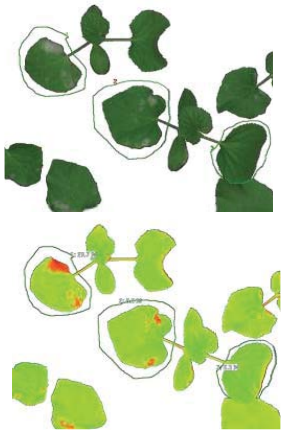
長期監測
Long-term tracking

Stress effect

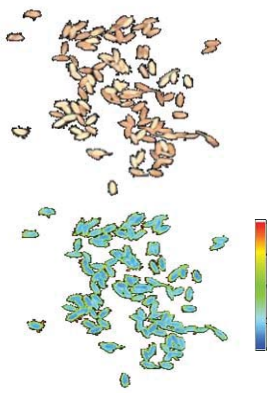


檢疫及品保
Quality control

Disease ranking



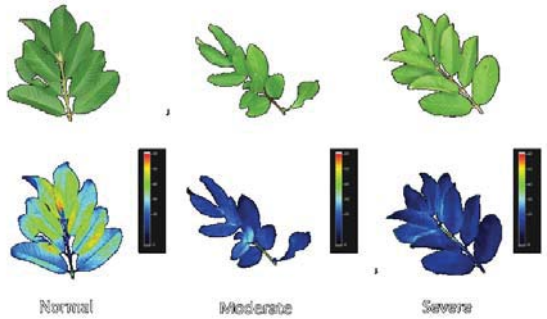
Digital breeding



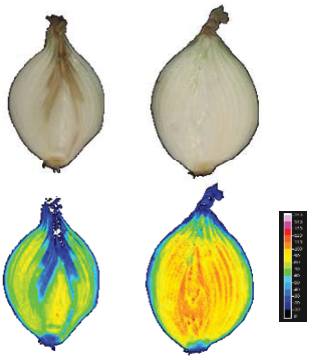
數位育種
Breeding

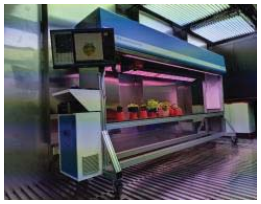
光譜建模
Modeling

Stage model of disease



Quality control







HiPoint 台灣海博特股份有限公司 NO.3.SOUTH 7TH RD.K.E.P.Z. KAOHSIUNG TAIWAN(R.O.C) TEL:+886-7-8128885 FAX:+886-7-8128336 http://www.twhipoint.com E-mail:sales@twhipoint.com
HiPoint LABORATORY · TAIWAN 80681高雄市前鎮區南七路3號(前鎮科技產業園區)

諾錡有限公司
NORKY CO., LTD.

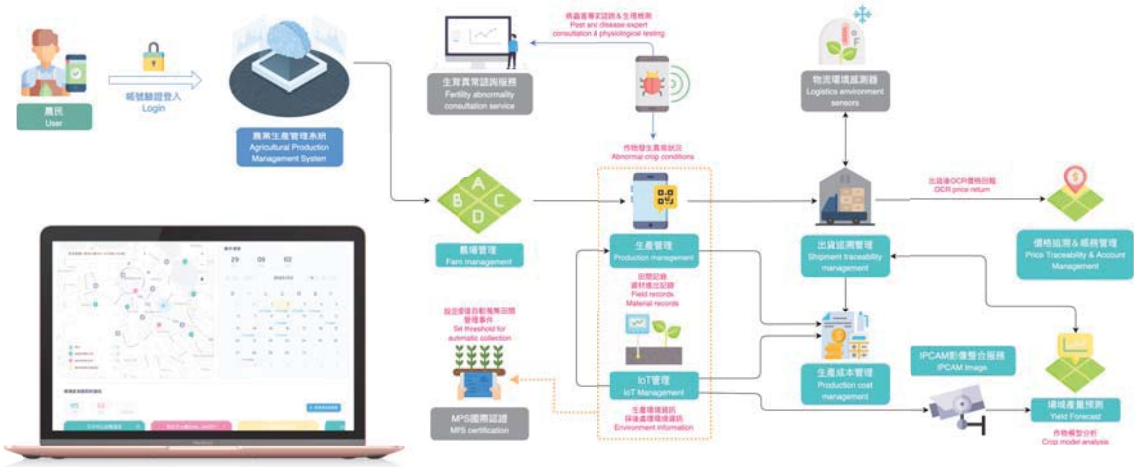
我們擅長於AI解決方案、開發資料分析、導入數位化及系統化之統整能力，開發之服務包含各領域數位化轉型、田間紀錄解決方案、AIoT整合監測方案於各規模之生產者進行導入使用。

We specialize in AI solutions, data analytics, digitalization, and systematization. Our services include digital transformation across various industries, digital field record-keeping, and AIoT monitoring solutions for agricultural fields, implemented for all scale producers.

農業生產管理系統 Agricultural Production Management System

透過數位化管理系統、物聯網技術及數據分析模式，運用於串接農業各階段產出的農產品內容資訊，包含生產管理、訂單分配、出貨管理及產品追溯，以建立產品完整的生產歷程。

Through digital management systems, AIoT technology, and data analysis models, we integrate product information across all stages of cultivation—including production management, order allocation, shipment management, and product traceability. This builds comprehensive traceability of agricultural products.

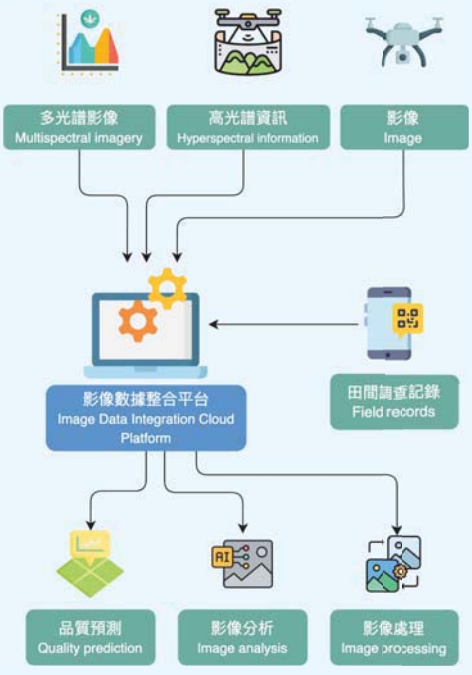


影像數據整合平台 Image Data Integration Cloud Platform

快速整合軟硬體
Integrate software and hardware

彈性客製化模組
Flexible customized modules

多樣化影像資訊管理
Multi-Image Management



透過M2M技術結合數位化流程，整合多源影像數據及現地調查資料，以建立準確且標準化的訓練資料，並提供各項客製化影像分析模型，包含光譜數據分析、多光譜影像分析及AI數據分析等開發能力。

By integrating M2M (Machine-to-Machine) technology with digital and systematic processes, incorporate multi-source image data and on-site survey information to create accurate and standardized training datasets. We offer customized analysis models tailored to your unique requirements, including spectral data analysis, multispectral image analysis, and AI analytics development capabilities.

E-mail:service@norky.com.tw

鍠麟機械有限公司
HUANG LIN MACHINERY CO., LTD.

049-232-8855
https://www.huanglin.com.tw/
hlm68168@gmail.com

鍠麟機械有限公司設立於2014年，我們建立農業設施智能環控品牌"GREENBELT"，開發「智能環控專家系統」依作物生理訊號，控制環境形成高產能作物生長微氣候，立即掌控各項生物所需的環境，給予最適當的配置以協助農業生產者生產高效能、省工、高品質及安全的農產品供應內需及外銷，以達到農作高收益。

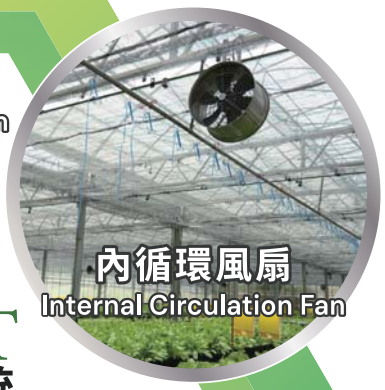
Huang Lin Machinery Co., Ltd founded in 2014, Huang Lin has built the "GREENBELT" brand for intelligent environmental control of agricultural facilities with the professional background of agricultural machinery. Our company is committed to becoming a high-quality agricultural machinery integrator and a leading model of agricultural facility system solutions and consulting services, to establish intelligent modular systems used in agriculture, fishery and animal husbandry, actively research and develop various intelligent environmental control equipment and systems.

遠端管理
Remote Management

即時監控
Real-Time Monitoring

溫室智慧監控系統
GREENBELT
Intelligent Environment System

氣象站
Weather Station Sensor



內循環風扇
Internal Circulation Fan

GREENBELT
智能環控專家系統

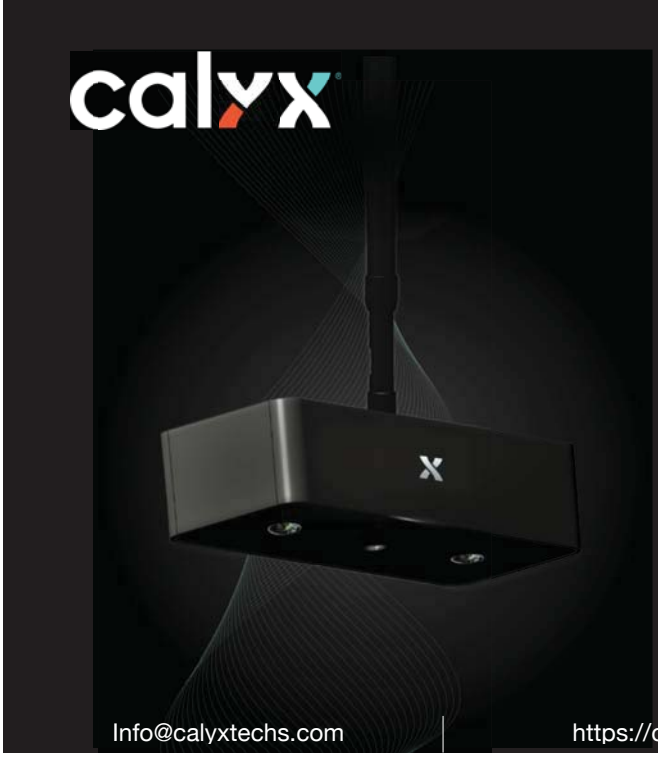
智慧農業戰情中心

噴霧降溫系統
Ice Spray Cooling
Intelligent Control System

灌溉系統
Automatic Drip
Irrigation System

植物生長LED燈
LED Growth Light High Efficient

OUR SERVICE



Sense Complexity

利用專有傳感器和人工智能計算機視覺技術，實時追踪家禽行業最重要的資產 - 雞隻。

Info@calyxtechs.com | https://calyxtechs.com | 聯絡我們: +886 2-2365-8520

多氣體檢測技術，靈感源自生物學

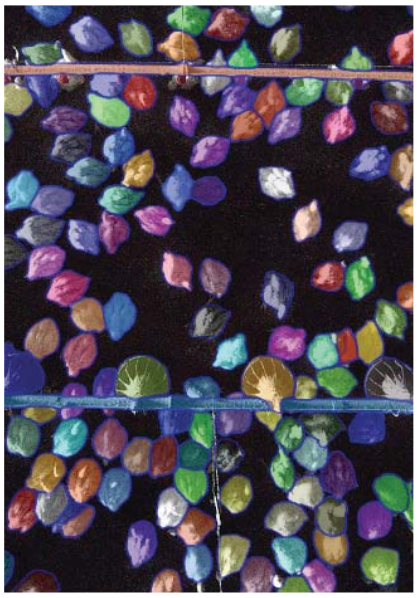
PRO PLUS Farm Monitoring

Calyx Y系列可讓農場主實時監測雞舍中的氨氣、二氧化碳、溫度與濕度，並可隨時隨地存取這些數據，主動調控環境條件，精確平衡通風、溫度與氨氣濃度，確保最佳的養殖環境。

該技術獲得專利，並由加州大學柏克萊分校與勞倫斯伯克利國家實驗室十餘年的工程研究支持。其高精度氣體傳感器採用先進的生物晶片技術，結合基因工程與化學工程，打造出高專一性的傳感器，能精確偵測並分析空氣中的環境及化學成分。

我們重新定義家禽產業，使客戶能夠專注於可創造更高價值的任務，這些任務之前他們沒有時間處理。

Calyx專有的AI 3D雞隻攝像頭幫助家禽行業從傳統的手動稱重轉型為基於AI的實時，且無需人力的雞群性能監測。該攝像頭還能提供前所未有的數據 - 實時客制生長曲線。



機器學習解決方案

使用多種A.I.技術來提高準確性

經過超過240萬隻雞的驗證

準確率達98.4%

Hugreen

善農科技股份有限公司

Hugreen Co., Ltd.

善農科技有限公司是一間國際企業，專注於農業科技。總部位於臺灣，業務範圍涵蓋環境監控感測器、農業自動化控制設備、軟體技術服務及農業技術諮詢等。我們的願景是用科技幫助農夫以更友善的方式耕種出更高經濟價值的作物。公司創立於**2016年**，並迅速成為世界現代農業技術領域的領先力量。我們的創新產品已遍布全球，包括歐美、澳洲及南非等地。經營理念起源於德國科學家對土壤的深刻感動。我們致力於推動有機友善農耕的轉型，並期待每位夥伴為此貢獻心力。

Hugreen Co., Ltd. is an international company focused on agricultural technology.Headquartered in Taiwan, our business covers environmental monitoring sensors, agricultural automation control equipment, software technology services, and agricultural technology consulting.Our vision is to help farmers grow higher-value crops in amore environmentally friendly way through technology.Founded in **2016**, the company has quickly become a leadingforce in the field of modern agricultural technology worldwide. Our innovative products are now spread across the globe, including in Europe, the Americas, Australia, and South Africa.Our business philosophy is rooted in the profound inspirationof German scientists' study of soil.We are committed to promoting the transition to organic and environmentally friendly farming, and we look forward to every partner contributing to this mission.

W https://www.hugreen.com.tw

+886 958-805-668

擎壤科技 Earthgen Tech

智慧農業與能源解決方案的無人機技術
DRONE TECH FOR SMART AGRICULTURE AND ENERGY SOLUTIONS

About Us

擎壤科技成立於2017年，專注於使用無人機技術推動智慧農業與光電清洗，結合AI與大數據分析，實現農業的自動化與高效能作業。

Earthgen Tech was established in 2017, focusing on using drone technology to promote smart agriculture and photovoltaic cleaning. By combining AI and big data analysis, we achieve automated and efficient operations in agriculture.

Our Services

農業 Agriculture
用於精準噴灑農藥和施肥，減少農藥使用，提升作業效率。
Used for precision spraying of pesticides and fertilizers, reducing pesticide usage and increasing operational efficiency.

漁業 Fisheries
透過無人機均勻灑播飼料，簡化養殖管理過程，提升作業效率。
Drones evenly distribute feed, simplifying aquaculture management and enhancing operational efficiency.

光電產業 Photovoltaic Industry
使用無人機清洗太陽能板，改善發電效能，減少人力投入。
Drones are used for cleaning of solar panels, improving power generation efficiency and reducing the need for manual labor.

自動化操作 Automated Operation
全自動飛行與作業，節省人工。
Fully automated flight and operation, saving labor.

高效能 High Efficiency
每日可處理大面積場域，提高作業效率。
Capable of processing large areas daily, improving operational efficiency.

安全性 Safety
降低工安風險，保證操作人員安全。
Reduces occupational safety risks, ensuring operator safety.

環保節能 Eco-friendly
減少農藥與水資源浪費，支持綠色永續發展。
Reduces pesticide and water wastage, supporting green and sustainable development.

+886-966-363-660 https://www.earthgen.com.tw service@earthgen.com.tw

皆展有限公司
Jin Jhan Greenhouse Project Co., Ltd

皆展溫室，立足台灣，走向世界！

Jin Jhan is Based in Taiwan, Goes into the World!

皆展有限公司成立於1998年，擁有30餘年專業溫室工程經驗，主要廠區佔地約4000平方公尺，結合上中下游策略夥伴約為132家，從規劃、設計、施工均由技術精良的專業團隊提供服務。主要營業項目為各類型農業設施溫網室、智慧化溫室及灌溉系統工程。

由於身處多颱風的亞熱帶地區，皆展秉持著「順天的防颱理念」，著重於發展溫室的鋼骨結構來與常見的颱風侵襲共處，長期以來，皆展也持續的發展智慧農業與AI智慧化環境控制技術，一步一腳印，已逐漸成為台灣溫室的領導品牌。皆展用心在每個溫室的建造，至今累積許多傑出案例，出口國家已超過30國，足跡遍佈全球四大洲，累積客戶已超過3000家，未來，皆展仍會持續發展最優良的溫室，將台灣製造的溫室帶向全世界。

Jin Jhan Greenhouse Project Co. Ltd. was founded in 1998 and covers an area ofapproximately 4000 square meters, cooperating with 132 strategic alliance manufacturers which are equipped with professional techniques of planning, design, and construction with a history of sophisticated greenhouse construction experience over 30 years.

Jin Jhan mainly produces large–scale greenhouses for various types of agricul–ture, artificial intelligence greenhouses and construction of irrigation schemes.

Situated in the tropical and subtropical zone, Jin Jhan has upheld the philosophy of "working with the nature, rather than against the nature", focusing on the research and development of greenhouse structures. Furthermore, we have dedicated to intelligent agriculture and AI environmental management technology along the way to become the leading brand of greenhouse in Taiwan.

Jin Jhan has deliberately planned each greenhouse and accomplished many successful cases. At present, the number of exporting cases has reached 30 coun–tries, expanding into four continents of the world. We are proud of having currently more than 3000 domestic and foreign clients. In the future, fin Jhan will continue developing the prominent greenhouse technology and bring it to the world stage.

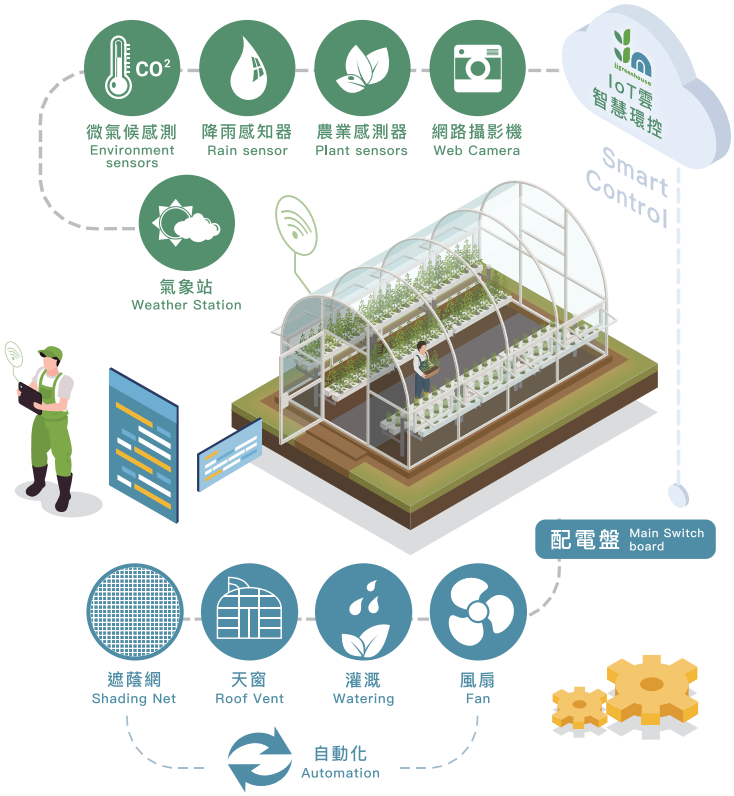
jjgreenhouse × IoT雲智慧環控系統 Cloud IoT Smart Control System

簡易型塑膠布溫網室
Simple Plastic Film Greenhouse

結構力霸型溫室
Robust Structure Greenhouse

精密型溫室
Precision Greenhouse

F–Clean農膜溫室
F-clean Greenhouse



皆展有限公司 Jin Jhan Greenhouse Project Co., Ltd
61642 嘉義縣新港鄉中洋村中洋子136號
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國立臺灣大學生物機電工程學系
財團法人農業機械化研究發展中心

Department of Biomechatronics Engineering, National Taiwan University
Taiwan Agricultural Mechanization Research & Development Center
Chinese Institute of Agricultural Machinery, Taiwan
Taiwan Institute of Biological Mechatronics
Center for Intelligent Agriculture Education and Research, National Taiwan University
Bioenergy Research Center, National Taiwan University
College of Bioresources and Agriculture (CBA), National Taiwan University