

# **2021 Research, Invention, and Innovation Congress: Innovation Electricals and Electronics (RI2C 2021)**

**Bangkok, Thailand  
1-3 September 2021**



**IEEE Catalog Number: CFP21RIB-POD  
ISBN: 978-1-6654-4833-8**

**Copyright © 2021 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP21RIB-POD
ISBN (Print-On-Demand):	978-1-6654-4833-8
ISBN (Online):	978-1-6654-0300-9

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

## Table of Contents

<b>Message from KMUTNB President</b> .....	<b>I</b>
<b>Keynote Speakers</b> .....	<b>II</b>
<b>Committee</b> .....	<b>VII</b>

### Contents

A Genetic Algorithm for Split Delivery Open Vehicle Routing Problem with Physical Workload Consideration ( <i>Tarit Rattanamaee</i> ).....	1
The Amount of Solid Waste Forecasting using Time Series ANFIS ( <i>Maleerat Maliyaem</i> ).....	5
Optimal Order Picking Route in Automotive Part Warehouse using Integer Programming ( <i>Janyaporn Cheewapongpan, Anan Butrat, Srisawat Supsomboon</i> ).....	9
Guidelines for Information Technology Governance Based on Integrated ISO 38500 and COBIT 2019 ( <i>Busarin Visitsilp, Nalinpat Bhumpenpein</i> ).....	14
Improving of Imbalanced Data in Multiclass Classification for Sentiment Analysis using Supervised Term Weighting ( <i>Jantima Polpinij, Khanista Namee</i> ).....	19
Time-Series Database Benchmarking Framework for Power Measurement Data ( <i>Lianne Kirsten Visperas, Yodsawalai Chodpathumwan</i> ).....	25
Low Cost Automated OS Security Audit Platform Using Robot Framework ( <i>Hachol Dabthong, Maykin Warasart, Phongsaphat Duma, Pongpat Rakdej, Natt Majaroen, Woraphon Lilakiatsakun</i> ).....	31
Water Quality Assessment in the Lam Pa Thao Dam, Chaiphaphum, Thailand with K-Means Clustering Algorithm ( <i>Phukkaraphon Ardarsa, Olarik Surinta</i> ).....	35
Smart Label Reader: The Prototype of Reading Aid for Thai Elderly ( <i>Noppagaw Thongbai, Yupin Suppakhuni</i> ).....	40
New Approach for Single Sign-on Improvement using Load Distribution Method ( <i>Surachai Chitpinityon, Maharat Tossa</i> ).....	44
Analysis of Logistical Aspect of Food-Safety System in the Green Supply Chain using Vehicle Routing Problem Model ( <i>Kasin Ransikarbum, Chewaphorn Chaiphaphan, Rattanan Pataratanased</i> ).....	48
Design of a Decision Support System for Vegetarian Food Flavoring by Using Deep Learning for the Ageing Society ( <i>Akksatcha Duangsuphasin, Athakorn Kengpol, Rui M. Lima</i> ).....	54
Deep Learning Approach for Complex Activity Recognition using Heterogeneous Sensors from Wearable Device ( <i>Narit Hnoohom, Anuchit Jitpattanukul, Ilsun You, Sakorn Mekruksavanich</i> ).....	60
An empirical study of intelligent virtual universal learning platforms ( <i>Sakchai Chaiyarak, Prachyanun Nilsook, Panita Wannapiroon</i> ).....	66
Learning Sentiments using Co-occurrence Analysis ( <i>Nirach Romyen, Sureeporn Nualnim, Maleerat Maliyaem, Herwig Unger</i> ).....	74
An Integrated 3D-Printed Lens with Ultra-wideband Flower-Shaped Stub Antenna for Ethanol-Water Mixture Characterization ( <i>Nonchanutt Chudpooti, Patchadaporn Sangpet, Nattapong Duangrit, Prayoot Akkaraekthalin, Ian Robertson, Nutapong Somjit</i> ).....	80
A Low-Cost Partially Reflective Surface for Gain Enhancement of Dual Polarized Microstrip Patch Antenna ( <i>Sukanya Praesomboon, Patchadaporn Sangpet, Suramate Chalermwisutkul, Danai Torrungrueng, Prayoot Akkaraekthalin</i> ).....	84

Non-Destructive Liquid-Mixture Sensor using Dual-Mushroom Resonator for Glucose Concentration Characterization ( <i>Sukanya Praesomboon, Patchadaporn Sangpet, Tanaporn Pechrkool, Suramate Chalermwisutkul, Prayoot Akkaraekthalin</i> ).....	88
Circularly Polarized Elliptical Patch Array Antennas for GPS ( <i>Ghaith Mansour, Ekasit Nugoolcharoenlap, Rashad H. Mahmud, Tossapol Tippo, Prayoot Akkaraekthalin, Danai Torrungrueng</i> ).....	92
Characterization of Glass Samples for On-Glass WiFi and UHF RFID Antenna Design ( <i>Muhammad Uzair, Apichart Kaewcharoen, Phornthip Tarbut, Suramate Chalermwisutkul</i> ).....	97
Interdigitated Capacitive Touch Sensor Integrated in Laminated Glass with a Large Sensing Area ( <i>Apichart Kaewcharoen, Suramate Chalermwisutkul</i> ).....	102
An X-Band Array Antenna for Forward Looking Radar in Collision Avoidance Systems of Locomotives ( <i>Thipamas Phakaew, Tiwat Pongthavornkamol, Prayoot Akkaraekthalin, Suramate Chalermwisutkul</i> ).....	106
Terahertz Free-Space Measurement System Using Low-Cost 3D-Printed Hemispherical Lens Antenna ( <i>Nonchanutt Chudpooti, Nattapong Duangrit, Prayoot Akkaraekthalin, Ian D. Robertson, Nutapong Somjit</i> ).....	110
Broadband Single-Mode Hollow Substrate Integrated Waveguide with Photonic Crystal Sidewalls for Multilayer System-in-Package Applications ( <i>Binbin Hong, Yanbing Qiu, Lei Sun, Guo Ping Wang, Nonchanutt Chudpooti, John E. Cunningham, Ian D. Robertson, Nutapong Somjit</i> ).....	115
Novel Hollow Substrate Integrated Waveguide for 5G and Robotic Applications ( <i>Giorgos Savvides, Nattapong Duangrit, Nonchanutt Chudpooti, Prayoot Akkaraekthalin, Ian D. Robertson, Nutapong Somjit</i> ).....	119
A Novel 24-GHz Miniaturized Flexible Rectifier for Wireless Energy Harvesting ( <i>Bilal Tariq Malik, Viktor Doychinov, Syed Ali Raza Zaidi, Nonchanutt Chudpooti, Nattapong Duangrit, Prayoot Akkaraekthalin, Nutapong Somjit, Ian Robertson</i> ).....	123
Study on the Detection of Object Buried under Railway by using Clutter Removal Technique ( <i>Pongsathorn Chomdee, Akkarat Boonpoonga, Titipong Lertwiriayaprapa</i> ).....	127
Inspection of Rail Sweep Using Matrix Pencil Method Based-Radar Target Identification ( <i>Pongsathorn Chomdee, Akkarat Boonpoonga, Titipong Lertwiriayaprapa</i> ).....	131
Design and Experiment of a Wideband Circularly Polarized Stacked Patch Antenna for Universal UHF RFID Readers ( <i>Sathaporn Konjunthes, Suramate Chalermwisutkul, Prayoot Akkaraekthalin, Wanwisa Thaiwirot</i> ).....	135
Multiband Thin Film Antenna for WLAN and LTE MIMO Systems ( <i>Suthat Hongdumnuen, Wanchalerm Chanwattanapong, Boonyarit Kumkhet</i> ).....	139
Solving Transmission-Line (TL) Problems Using Simple Coupled Integral Equations and the Method of Moments (MM) for Undergraduate Education ( <i>Itthinat Jongsuebchoke, Danai Torrungrueng, Prayoot Akkaraekthalin</i> ).....	143
Wideband Impedance Matching Using Quarter Wave-Like-Transformers Implemented by Asymmetric Compact Microstrip Resonant Cells ( <i>Sangwon Kittiwittayapong, Danai Torrungrueng, Kittisak Phaebua, Titipong Lertwiriayaprapa, Prayoot Akkaraekthalin, Kitiphon Sukprecha</i> ).....	149
Synthesis of Multicultural Digital Publicist Competencies ( <i>Phudit Kannikar, Panita Wannapiroon, Prachyanun Nilsook</i> ).....	154
Synthesis of Digital Supervisor Competency ( <i>Chutirut Prasongmanee, Panita Wannapiroon, Prachyanun Nilsook</i> ).....	161
Transition Elements, Enterprise Architecture for Digital Entrepreneurial University ( <i>Tippawan Meepung, Panita Wannapiroon, Prachyanun Nilsook</i> ).....	167
Augmented Intelligence Coaching System ( <i>Sajeewan Pratsri, Prachyanun Nilsook, Panita Wannapiroon</i> ).....	176

The Development of 4D Model for Learning Management with Free Platform to Encourage The ICT Literacy Skills of Undergraduates ( <i>Kanitta Hinon</i> ).....	183
Transfer of a scientific concept in the field of renewable energy with a creative group work ( <i>Seyyed Amin Sadat Sakkak, Mohammad Afkar, Roghayeh Gavagsaz-Ghoachani, Matheepot Phattanasak</i> ).....	187
Effect of wide observation of nature in renewable energy engineering education ( <i>Yeganeh Ghandriz, Seyed Mohamadreza Ziaiean Noorbakhsh, Roghayeh Gavagsaz-Ghoachani, Matheepot Phattanasak</i> ).....	193
Attractive educational strategy based on the story that hybrid vehicles integrated with the human family ( <i>Amin Yousefi, Roghayeh Gavagsaz-Ghoachani, Matheepot Phattanasak</i> ).....	199
Investigating the transfer of scientific content with the help of comic stories at a level of higher education ( <i>Parham Karimi, Roghayeh Gavagsaz-Ghoachani, Matheepot Phattanasak</i> ).....	205
Classes of Dual to Modified Ratio Estimators for Estimating Population Mean in Simple Random Sampling ( <i>Natthapat Thongsak, Nuanpan Lawson</i> ).....	211
A Study on the Design of A Semi-Cylindrical Capacitive Sensor for Intravenous Drip Detection ( <i>Theera Leeudomwong, Chissanuthat Bunluechokchai</i> ).....	216
Modified Sliding Mode-Based Control of a ThreeLevel Interleaved DC-DC Buck Converter for Proton Exchange Membrane Water Electrolysis ( <i>Burin Yodwong, Damien Guilbert, Wattana Kaewmanee, Matheepot Phattanasak, Melika Hinaje, Gianpaolo Vitale</i> ).....	221
Design, Development, and Fabrication of an Intravenous Infusion Monitoring Device ( <i>Natapol Phetsuk, Sumet Umchid</i> ).....	227
A New Low-cost Hardware-in-the-Loop Simulator for Control of Power ( <i>Wattana Kaewmanee, Burin Yodwong, Suwat Sikkabut, Matheepot Phattanasak, Damien Guilbert</i> ).....	233
Design of Approximate 2DOF Digital Control for Widely Dimming LCL-T Resonant LED Driver ( <i>Satit Mangkalajan, Kamon Jirasereeamongkul, Kohji Higuchi</i> ).....	238
Temperature Controlling and Monitoring System of Mao-Wine Aging Tank for Local Enterprises ( <i>Kongphope Chaarmart, Athorn Vora-ud, Tosawat Seetawan</i> ).....	243
Mini-Potentiostat for Low Power Chemical Sensing of Graphene-Carbon Paste Lab on a Chip ( <i>Kessarat Ugsornrat, Triwit Phurksasukkasem, Assawapong Sappat, Chakrit Sriprachuabwong, Chan pen Karuwan, Adisorn Tuantranont</i> ).....	247
Application of Fall Detection for the Elderly: A Case Study of Thailand ( <i>Tapanee Treeratanaporn, Sopanut Keton, Kittayanun Roengketgorn, Benyapha Phoonthongkham</i> ).....	252
An Optical Fiber Monitoring and Alert System for A Passive Optical Network Based on IoT ( <i>Pubet Sangmahamad, Tanaporn Pechrkool, Puttiporn Thiamsinsangwon</i> ).....	258
Evaluation of the Performance of a Controller Based on Indirect-Sliding Mode in a Renewable System ( <i>Mohammad Afkar, Roghayeh Gavagsaz-Ghoachani, Matheepot Phattanasak, Serge Pierfederici</i> ).....	262
Stability and robustness investigation of a modular system using a large-signal average model ( <i>Mohammad Afkar, Roghayeh Gavagsaz-Ghoachani, Matheepot Phattanasak, Serge Pierfederici</i> ).....	268
Design Guidelines of Passive Balancing Circuit for Li-Ion Battery for Bleeding Current Adjustment Using PWM Technique ( <i>Supanat Apipatsakul, Nisai Fuengwarodsakul, Manop Masomtob</i> ).....	273
A Comparison of MPPT Solar Charge Controller techniques: A Case for Charging Rate of Battery ( <i>Chantima Lapsongphon, Supaporn Nualyai</i> ).....	278

The Development of Deep Learning Methods to Select Passion Fruit for the Ageing Society ( <i>Akksatcha Duangsuphasin, Preecha Rungsaksangmanee, Athakorn Kengpol, Kalle Elfvengren</i> ).....	282
Overmind, A Collaborative Decentralized Machine Learning Framework, the Interpretation of Network Behaviour ( <i>Puttakul Sakul-Ung, Hathairat Ketmaneechairat, Maleerat Maliyaem</i> ).....	288
Mobile Warehouse Management and Transportation Planning System for Wheat Flour ( <i>Auttanit Wongjak, Sukanya Chansamorn</i> ).....	293
Deep Learning Technique for a Identify TE Student System by Face Recognition ( <i>Kanokwan Klinieam, Panee Noiying</i> ).....	298
Text Compare and Grouping Program using Dynamic Programming Algorithm ( <i>Auttanit Wongjak</i> ).....	303
LoRa Network Based Multi-Wireless Sensor Nodes and LoRa Gateway for Agriculture Application ( <i>Wanchalerm Chanwattanapong, Suthat Hongdumnuen, Boonyarit Kumkhet, Supaset Junon, Pubet Sangmahamad</i> ).....	307
Automatic Sorting Machine Using Industrial Robot and Digital Image Processing ( <i>Chanin Joochim, Phongsak Keeratiwintakorn</i> ).....	311
A Machine Vision Approach for Copper Plating Quality Control System Development ( <i>Kanokwan Klinieam, Panee Noiying</i> ).....	317
A Training Set of Digital Image Processing for Object Inspection Using LabVIEW ( <i>Meechai Lohakan, Chainarong Yensiri, Choochat Seetao, Pornwilai Sukmak</i> ).....	321
Fully Connected Autonomous Subassemblies to Enable FMS and Apply Lean’s Kanban for Workflow Management ( <i>Prasert Jirashayanon</i> ).....	327
The Comparison of Methods for Mass Measurement on the Continuing Movement Conveyor using Digital Processor ( <i>Wittaya Koodtalang, Natee Thong-Un</i> ).....	336
Non-population Metaheuristics with a New Fitness Evaluation to Minimise Total Penalty Costs for a Hybrid Flow Shop with Assembly Operations Scheduling Problem ( <i>Watcharapan Sukkerd, Jakkrit Latthawanichphan, Teeradej Wuttiornpun, Watchara Songserm</i> ).....	340
An Improvement of Instance Generator Featuring Assembly Operations with Parallel Machines for Multi-Level and Multi-Operation Scheduling Problems ( <i>Watchara Songserm, Jakkrit Latthawanichphan, Teeradej Wuttiornpun, Watcharapan Sukkerd</i> ).....	347
<b>Author Index</b> .....	<b>357</b>