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TABLE OF CONTENTS:-

i-SPIKE 2021 International Exhibition & Symposium E-Proceedings

NO.	TITLE	PAGE
1.	‘Viewfinder’ Mobile Learning Application for Videography and Cinematography Based on the Rules of Perspective <i>Amir Nor Azan Samar, Harim Izzati Hamdan, Iqbal Jaapar & Muhammad Firdaus Amairudin</i>	1
2.	Systematic Alternative Fuzzy Logic Evaluator (SAFLE) for Student Performance Evaluation <i>Shirley Sinatra Gran, Tracy Adeline Ajol & Awang Nasrizal Awang Ali</i>	8
3.	360 Employees – I <i>Dayang Hazenah Awang Abdul Hamid, Nur Dina Athia Mohd Ramley, Nur Hidayah Jusoh, Nurul Husna Abd Jalil & Mohammad Firdaus Mohammad Hatta</i>	12
4.	AbMTI: Adventure Based Mental Toughness Inventory for Post Covid-19 Pandemic Era <i>Mohd Shariman Shafie, Professor Dato Dr. Md Amin Md Taff, Dr. M.Adli bin Mohd Sidi, Mohamed Azizul bin Mohamed Afandi, Dr. Omar Firdaus Mohd Said & Nik Jazwiri Johannis</i>	18
5.	AbMTM: Post Covid-19 Adventure-Based Mental Toughness Training Model <i>Mohd Shariman Shafie, Professor Dato’ Dr. Md Amin Md Taff, Assoc. Professor Dr. Zuraidah Zainol & Dr. Siti Musliha Mat Rasid</i>	23
6.	Pembentukan Modul Undi18@School untuk Pendidikan Kenegaraan dan Demokrasi kepada Belia 18-21 Tahun <i>Wan Rohila Ganti Wan Abdul Ghapar, Che Hamdan Che Mohd. Razali, Muhamad Fazil Ahmad & Abdul Rahman Abdul Latip</i>	28
7.	A Planning of Templer Forest Park and Templer Forest Reserve through Management Plan <i>Mohammad Zharif Hakimi Mohammad Mazani, Nurul Atikah Mohd Salleh, Muhammad Hafiy Safwan Sahak, Nurul Nabila Che Ahamed, Teeny Valerian, Mohamad Fathi Radhi Ishak, Nor Hanisah Mohd Hashim & Firdaus Chek Sulaiman</i>	33
8.	Administrative Model for Sekolah Agama Rakyat (SAR): Excellence Practices <i>Mohd Nasir Ayub, Nazmi @ Nazni Noordin, Mohd Zool Hilmie Mohamed Sawal & Surita Hartini Mat Hassan</i>	38
9.	ADR-Now Application: Bridging Theoretical and Practical Approach in Alternative Dispute Resolution Process and Procedures <i>Dr. Shahrizal Mohd Zin, Abdul Mu’iz Abdul Razak, Prof. Madya Dr. Nur Ezan Rahmat & Nik Hasbi Fathi</i>	43

10. Agricultural Career Training Program for Drop Out Students through Work Based Learning 47
Marinah Muhammad, Noor Janatun Naim Jemali, Nik Raihan Nik Yusoff & Rozidaini Mohd Ghazi
11. An Eco-Friendly Concrete Blends from Palm Oil Boiler Ash 52
Nurrul Amilin Zainal Abidin, Zeno Michael, Mohamed Khatif Tawaf Bin Mohamed Yusof, Azmi Roslan, Siti Shahidah Binti Sharipudin, Shahrul Nizam Bin Mohammad & Ilya Izyan Binti Shahrul Azhar
12. An Investigation of Clothing for Elderly: Emphasizing Safety, Protection and Functional Attributes 57
Shahrizad Fitri Mustapha, Shuhaila Nahrawi, Rizal Azni Dahaman & Norzaleha Zainun
13. Ardu-Electrochromic Film for Home Safety And Privacy Purpose 65
Anas Akasyah Abd Patas, Nur Athirah Mohd Taib & Syahida Suhaimi
14. Let's Talk about the Movies: The Movie Journal 71
Associate Profesor Dr Norwati Binti Hj Roslim, Associate Profesor Dr Hj, Muhammad Hakimi Tew Abdullah, Ku Nurul Atiqah Ku Ahamad, Nur Faathinah Mohammad Roshdan, Suhaila binti Sharil & Siti 'Aishatul-Humairah Muhammad Fisol
15. Asymmetric Impact of The Oil Price Changes on Stocks Market for Selected Asean Countries 78
Shahiszan binti Ismail, Prof. Madya Dr. Noor Zahirah Mohd Sidek, Fauziah Mohamad Yunus, Jamilah Laidin & Nor Azira Ismail
16. Automated System for Concrete Damage Classification Identification Using Various Classification Techniques in Machine Learning 81
Nur Haziqah binti Mat, Athifa Aisha binti Ahmad Zahida, Siti Nurhaliza binti Abdul Malik, Nur Athirah Syuhada binti Azmadi & Syahrul Fithry bin Senin
17. Automatic Price Scanning System 88
Fahmi Nazreen Zakuan, Anis Diyana Rosli & Nurlida Ismail
18. Al Hijjaei V1 94
Yuslina Mohamed, Mesbahul Hoque, Sulaiman Ismail Nurhasma & Muhamad Saad
19. Infographic of Benevolence Practices: Public Sector's Myth or Reality 100
Dr Nor Zaini Zainal Abidin, Azni Syafena Andin Salamat, Syahrini. Shawalludin, Azlan Abdul Rahman & Dr Siti Norfazlina Yusoff
20. BIO-CHEM KIT: Understanding Biogeochemical Cycles 104
Nurul Hidayana Mohd Noor, Shawal Sahid Hamid@Hussain, Mahazril 'Aini Yaacob & Mohd Hafiz Hazwan Hashim

21.	Biodegradable and Recycle Husk Mailer from <i>Cocos nucifera</i> <i>Anas Firdaus bin Zakaria, Nur Atirah binti Hamzah, Siti Farahin binti Abdull Patah, Wan Zuraida Wan Mohd Zain & Nur' Amira binti Hamid</i>	110
22.	Bunny's Pellet: Natural Mulberry Pellet <i>Nor Dini Rusli, Khairiyah Mat, Hasnita Che Harun, Mohd Mahmud & Syed Muhammad Al-Amsyar Syed Abd. Kadir</i>	114
23.	Cails Paper Wash <i>Aisyah Nur Izzah binti Azhar, Intan Nafissa binti Mohd Jaffri, Loris Anak Noh, Caroline Anak Kiroh & Silverina Anabelle Kibat</i>	120
24.	Capcut <i>Dr Sharifah Shafinaz Sh Abdullah, Nur Afini Azwa binti Roslan, Nur Alya Nabila binti Ashariman, Nur Mazmira binti Mohamad Zuki & Nur Nabila binti Omar</i>	124
25.	Regenerated Kenaf Core Cellulose Hydrogels and Films Prepared via Pre-Cooled Method <i>Adam Khairul Faiz, Muhammad Khairil Hakim Ismail, Hatika Kaco & Mohd Shaiful Sajab</i>	128
26.	Encapsulation of Winged Termites in Cellulose Nanofibre for the Fabrication of Cellulose Bioplastic <i>Syahidatul Nadhilah Shah Lail, Noorul Jannah Aizul Hussin, Hatika Kaco & Mohd Shaiful Sajab</i>	134
27.	Chinese Character Card Game: Learners' Attitudes and Motivation <i>Ting Hie-Ling</i>	140
28.	Coffee Capsule Vending Machine <i>Mohd Sufian Ramli, Siti Sufiah Abd Wahid, Muhammad Hasif Razak & Muhammad Hakimi Md Said</i>	146
29.	Corn-Based Bioplastic as Seedling Bag <i>Nur Nadia Nasir & Siti Amira Othman</i>	151
30.	Coupiers: Course Pre-Registration System <i>Zeti Darleena Eri, Mohd Hanapi Abdul Latif, Mohd Atif Ramlan, Ruhana Jaafar, Sharifah Nurulhikmah Syed Yasin, Hasiah Mohamed & Sarah Yusoff</i>	156
31.	Divorce Protection Takaful <i>Siti Thaqifah Ruzaidy, Siti Adibah Embong, Mohammad Firdaus Mohammad Hatta & Arlinah Abd. Rashid</i>	162
32.	Entrepreneurial Website Project "Www.Businessletter4you.Com" <i>Akmal Syaifudin bin Kaharudin, Siti Zuraina binti Gafar @ Abd Ghaffar & Juritah Misman</i>	168

33.	Early Flash Flood Detection and Avoidance System <i>Muhammad Aidil Aisar Mohd Yatim, Muhammad Khalis Zuhri Izahar, Rohaiza Baharudin & Mohd Hussaini Abbas</i>	174
34.	Ebook: Easy Research For All <i>Sylvia Nabila Azwa Ambad</i>	180
35.	e-Info_JK Formation Committee System for the School of Civil Engineering (Pka) Universiti Teknologi MARA <i>Azlinda Saadon, Musmuliadi Kamaruding, Syahrin Neizam Mohd Dzulkifli, Mazidah Mukri, Noraida Mohd Saim, Dzulaikha Khairuddin & Siti Hamidah Abdull Rahman</i>	183
36.	E-Module <i>ABRA-Maths</i> - Early Mathematics Learning via Mini Tennis <i>Rahela Abdul Rahim, Haslinda Ibrahim, Fauziah Baharom, Mohd. Rahizam Abdul Rahim & Syahrul Ridhwan Morazuki</i>	189
37.	Enhanced Microwave Heat Susceptor Crucible <i>Assoc. Prof. Dr. Muhammad Azwadi Sulaiman, Fathin Asila Mohd Pabli, Syifa' Muhamad Sharifuddin, Assoc. Prof. Dr. Julie Juliewatty Mohamed & Dr. Norfadhilah Ibrahim</i>	194
38.	Enhancement of Latent Fingerprint Using Dyed Eggshell Powder <i>Kavitha Rajagopal</i>	198
39.	Product Development - E-Personal Possessions Takaful (e-PPT) <i>Siti Hasnulbariah binti Ahmad Rusmili, Nor Ashikin binti Dal Nia, Dania Carmila binti Said, Mohammad Firdaus bin Mohammad Hatta & Norzanah binti Mat Nor</i>	200
40.	E-Pocket Note: An Interactive Video Learning for Effective Online Teaching and Learning Process <i>Norhayati Zamri, Nor Bahiyah Omar, Norul Akma Mansor, Liyana Ab Rahman & Farah Husna Mohd Fatzel</i>	205
41.	The Clauses SMM2 at Construction Site Board Game For (WBLFF) <i>Roseline anak Ikau, Zafikha Aida Bidin, Syamimi Liyana Amat Rais, Amira Shazlin Adnan & Mohd Khairul Fitri othman</i>	210
42.	e-Voting: Votehere4u 2.0 <i>Adib Sarkawi, Aiza Johari, Azlina Bujang & Zainon Haji Bibi</i>	215
43.	IO2TX <i>Dr Sharifah Shafinaz Sh Abdullah, Nur Afini Azwa binti Roslan, Nur Alya Nabila binti Ashariman, Nur Mazmira binti Mohamad Zuki & Nur Nabila binti Omar</i>	220

44. Waste Segregation through Recycle and Composting Activities among the Community in Urban and Suburban Areas 225
Ts. Dr. Norhafezah binti Kasmuri & SitiNurhafizah binti Abdull Razak
45. Ez-Crutches 2.0: An Innovation of Assistive Device for Disabled Person 231
Suzana binti Yusof, Sharifah Shafinaz binti Sharif Abdullah, Fatimah binti Sham & Norhafizatul Akma binti Shohor
46. Facile-Fabricated Foamed Geopolymer Sphere for Heavy Metal Removal from Wastewater 236
Tan Tee How, Mo Kim Hung, Lai Sai Hin & Ling Tung-Chai
47. Finance and Me (*FinME*) – A Digital Learning Tool 242
Carolyn Ann Enchas, Shafinaz Lyana Abu Talib, Fatin Adilah Razali & Norizuandi Ibrahim
48. Fun with Mathematic and Origami: Water Lily Origami 246
Masnira Ramli, Wan Nurul Husna Wan Nordin, Amirah Sa'at & Nurul Fazila Lakasa
49. Fund for Food: A Campus Food Pantry Toolkit to Help Fight Hunger on Campus 252
Nurul Hafizah Mohd Yasin, Nurhaiza Nordin, Nurnaddia Nordin, Nik Noorhazila Nik Mud & Siti Zamanira Mat Zaib
50. Edible Cookie Cup: Cuppa Cookie 257
Raja Nur Hanisah Binti Raja Zainal Alam Shah, Nur Liyana A'tifah Binti Ahmad Jamalulail, Nur Farah Aqilah Binti Mohd Akram, Amara Nazirah Binti Mohd Yusoff & Noorshaadah Binti Omar
51. GTNLARM21 262
Ts. Dr. Sharifah Shafinaz binti Sh Abdullah, Assoc. Prof. Ts. Dr. Zulkifli bin Mohamed , Aisyah Fitriah binti Asmala , Nur Fatimah binti Hanif & Nur Hanisah binti Mahadi
52. Gulali Pandan 267
Amelia binti Zaidan, Ainul Hayati binti Abdull Aziz, Nurul Syamilah binti Ismail, Noristisarah Abd Shattar & Siti Noraisah Dolah
53. Hill Paddy Plough 272
Jasrio Liugan, Sainah binti Melulin, Zurhizainih binti Halledy & 'Umairah Abd Khalid
54. Historic Interior Scheme (HIS) Conservation Framework for Heritage Museum Building in Malaysia 275
Norashikin Abdul Karim, Siti Norlizaiha Harun, Salwa Ayob & Zulkarnain Hazim

55.	I-Poket Perumahan: Panduan kepada Newbie <i>Mahazril 'Aini Yaacob, Nurul Hidayana Mohd Noor, Hafizah Hammad Ahmad Khan, Zuraini Yaacob & Farah Amirah Fuad</i>	283
56.	Development of HVAC Virtual Laboratory (HV-Lab Version 1.0) <i>Mohd Faez bin Zainol, Ts. Shikh Ismail Fairus bin Shikh Zakaria & Dr. Muhammad Zulkarnain</i>	287
57.	i-Care2u: Easy-To-Use Application Software to Enhance Knowledge and Awareness of Malaysians towards the Rights of Persons with Disabilities <i>Muhammad Fikri Othman, Nur Ezan Rahmat, Norazlina Abdul Aziz, Nora Abdul Hak & Diyana Kamarudin</i>	293
58.	Immersive Learner's Usability and Experience through VMMBG during Covid-19 Pandemic: An Evidence of a Higher Educational Institution <i>Shahreena Daud, Idris Osman, Zarinah Abu Yazid, Norraeffa Md Taib & Amirudin Mohd Nor</i>	297
59.	VCDDT: The Virtual Classroom Debate Tutorial Approach <i>Azlyn Ahmad Zawawi, Junaida Ismail, Irwana Nooridayu Mohd Hakimi Noorayuni Rusli & Intan Syahriza Aziz</i>	304
60.	Indikator Teknik Pengajaran Bahasa Arab di UiTM Menerusi Teknologi <i>Nurul Asma Mazlan, Suhaila Zailani @ Ahmad, Zamri Arifin, Mohd Faizulamri Mohd Saad & Nur Aqilah Norwahi</i>	307
61.	Inquiry-Based Reciprocal Teaching Module <i>Ting Pick Dew, Suyansah Swanto & Vincent Pang</i>	311
62.	Instant Beef Stew <i>Nursyadah binti Nordin, Norhidayah bt Abdullah & Muna Shakirah bt Mohamad</i>	316
63.	Integrated Solar-IoT Monitoring and Predictive Maintenance Systems for Irrigation (S-IoTP) <i>Hasyiya Karimah Adli, Ku Azmie Ku Husin, Khairul Nizar Syazwan Wan Salihin Wong & Muhammad Akmal Remli</i>	320
64.	IOT Based Monitoring System for Oyster Mushroom Farming Pondok Seri Permai Pasir Putih Kelantan <i>Muhd Azhar Bin Zainol, Sh Mohd Firdaus Bin Sh Abdul Nasir, Nor Suhada Binti Abdullah, Koay Mei Hyie, Siti Nur Amalina Binti Mohd Halidi, Hazimi Bin Ismail & Lesairuamin Bin Leiah</i>	325
65.	IoT Based Water Leakage Monitoring System <i>Muhammad Azfar Shazmi Mohd Adnan & Zulkifli Mohamed</i>	334
66.	i-Tabung <i>Dayang Aniisah Mardhiyyah binti Abg Borhanuddin, Mohamad Nornashriq Irfan bin Nordin, Muhammad Akram bin Nazri, Muhammad Azwar Naim</i>	340

bin Amilan, Muhammad Fadhillah bin Mohd Zam Zam, Mohd Fazly bin Mohd Razali & Ima Ilyani binti Dato' Hj. Ibrahim

- | | | |
|-----|--|-----|
| 67. | <p>Kaedah Pengajaran CHM510: Dari Sudut Pandang Pelajar
 <i>Sheikh Ahmad Izaddin Sheikh Mohd Ghazali, Nur Nadia Dzulkifli, Nor Monica Ahmad, Jamil bin Mohamed Sapari, Ahmad Husaini Mohamed & Nurul Nadthira binti Che Awang</i></p> | 343 |
| 68. | <p>Ke Arah Kelestarian Kebun Komuniti dalam Usaha Menyantuni Golongan B40
 <i>Intan Syafinaz Mat Shafie, Yuslina Liza Mohd. Yusof, Nor Irvoni Mohd Ishar, Maryam Jameelah Mohd Hashim, Mohd Fairus Kholid, Muhammad Yasin Ramadhan Zahari & Sharidatul Akma Abu Seman</i></p> | 348 |
| 69. | <p>Uniquicare Takaful
 <i>Muhammad Sa'di Bin Mohd Saman, Nur Aimi Binti Abdul Azis, Mohammad Firdaus Bin Mohammad Hatta & Azlina Binti Hanif</i></p> | 353 |
| 70. | <p>#Kitajagakita: The Manifestation of Modern Jewellery Design
 <i>Mohd Faiz Jalaludin, Mohd Hakim Mohd Sharif, Adib Mohd Hasan & Muhammad Shafiq Muda</i></p> | 359 |
| 71. | <p>Kombu-Feed: A Nutritive & Prophylactic Alternative for Fish Production
 <i>Ruhil Hayati Hamdan, Tan Li Peng, Nora Faten Afifah Mohamed, Ain Auzureen Mat Zin & Ahmad Syazwan Samsuddin</i></p> | 363 |
| 72. | <p>Kriging Interpolated Rainfall Data in ArcGIS for a Sustainable Flood Modelling Prediction
 <i>Fahda Nurhani Ahmad Razan, Nur Fatim Nasuha Mhd Khatif & Ir. Nur Azwa Muhamad Bashar</i></p> | 368 |
| 73. | <p>Kuasai Rintas: Penulisan Ringkasan Bahasa Melayu Yang Lengkap
 <i>Gladys Sebi binti Entigar, Noor Haty binti Noor Azam, Milfadzhilah binti Mohd Jamil, Roziana binti Ahmed & Nur Elimtiazh bin Abidin</i></p> | 373 |
| 74. | <p>Landscape Architecture Design Studio-Based Using Process-Evaluation Model in Open Distance Learning
 <i>Masbiha Mat Isa, Alamah Misni & Faridatul Akma Ab Latif</i></p> | 378 |
| 75. | <p>LiBCO
 <i>Noryana binti Ahmad Khusaini, Nur Hasni binti Nasrudin, Mohd Shamsul bin Daud, Noraini binti Abd Rahman, Rosida binti Ahmad Junid & Siti Fairuz binti Ibrahim</i></p> | 382 |
| 76. | <p>Limit of Acceptable Change and Recreation Opportunity Spectrum as a Tool in Developing a Management Plan. A Study in Templer Forest Eco Park & Templer Forest Reserve</p> | 388 |

	<i>Syahidah Hanani Hamdan, Nur Sabrina Sabri, Muhammad Hazim Zakaria, Khairul Asri, Syanizatul Izreen Kamal, Nor Asma Safuraa Roslan, Ely Rouzee Jamaluddin & Nawfal Kamarul Bahrain</i>	
77.	Tweet It! EsL Writing Activity Module Using Twitter <i>Nurshahirah Azman & Zaemah Abd Kadir</i>	393
78.	Malaysian Secondary Boarding School Menu Planning System <i>Suliadi F. Sufahani & Anuar M. Yusof</i>	399
79.	Malaysian Studies Pocket Read <i>Ani Juaini Bahrin, Farhana Yaakub, Firdausi Sufian (Dr), Nurfaizah Abdullah & Saiful Zizi Jalil</i>	405
80.	Mathematical Thinking Enhancement Program (MaTh-EP) <i>Nurul Akmal Md Nasir, Parmjit Singh & Geethanjali Narayanan</i>	410
81.	Medicine Reminder With Low Battery Alert “MEDMINDER” <i>Syahirah Asyiqin Binti Alias, Luqman Hakim Bin Fazilah Shuhaimi, Khairin Farhana Binti Kharul Anuar, Muhammad Firdaus Bin Mangsor & Suhana Sulaman</i>	418
82.	Meow-Meow Food Dispenser Using Internet of Things (IOT) Programme <i>Nor Diyana Md Sin, Saifaris Azizi Saiful Azam, Muhamad Danial Osman, Mohamad Zhafran Hussin, Norbaiti Sidik, Khairul Kamarudin Hasan</i>	424
83.	Mesin Penapis Turpentin Turpentine Filter Machine (TFM) <i>Hairulnisak binti Merman, Muhammad Salehuddin bin Zakaria, Aiman Yusri bin Mohamad Yusoff, Aimi Atikah binti Roslan & Azian binti Tahir</i>	429
84.	Mind Your Right Booklet: Awareness on Cyber Defamation Law & Media <i>Suria Fadhillah Md Pauzi, Musramaini Mustapha, Azniza Ahmad Zaini, Suhanom Mohd Zaki & Mohd Aidil Riduan Awang Kader</i>	434
85.	Modelling the Effectiveness of Using Online Food Delivery Services Apps Among Customers in Klang Valley During Covid-19 Pandemic <i>Prof Madya. Dr Rozita Naina Mohamed, Mohd Saifullah Bin Rusli & Prof.Madya. Dr.Halimahton Borhan</i>	440
86.	The Innovation Process Modelling for Ethanol Gas Sensing Using Artificial Neural Network <i>Muhammad Afiq Wazini bin Jemani, Vicinisvarri Inderan, Syahrul Fithry bin Senin, Norain Binti Isa & Lee Hooi Ling</i>	447
87.	The Effectiveness of i-Lab v2 as a Teaching Tool for Online Distance Learning <i>Nur Zaidani Wati binti Mohd Darwis, Noor Raifana binti Ab Rahim, Narita binti Noh & Juwita binti Asfar</i>	453

88.	My Ecredit Banking Apps (MECBA) V3 <i>Wan Razazila Wan Abdullah (Dr), Enny Nurdin Sutan Maruhun (Dr), Norzarina Nordin, Sunarti Halid & Ahmad Saiful Azlin Puteh Salin (Prof. Madya Dr)</i>	459
89.	The Dynamics of MILO (Multimedia Interactive Learning Online) in Role Playing: Enhancing the Learning Process in Covid-19 Pandemic <i>Woo Pak Yuan, Nina Farisha binti Isa & Ezwani Azmi</i>	464
90.	The Continuance of External Review Information System Adoption In Malaysia <i>Mohd Norafizal Abd Aziz, Razulaimi Razali, Nik Rosli Abdullah & Shahrul Azam Abdullah</i>	470
91.	Understanding Islamic Finance Concepts through Innovative Game: Name The Riba Transaction! <i>Azilawati Banchit, Puteri Faida Alya Zainuddin & Lai Tze Wee</i>	479
92.	Natmag Cleaner (Natural Magnificent Cleaner) <i>Hani Hasriena binti Hasrin, Muhammad Firdaus bin Ahmad Nizam, Nur Amalin Batrisya binti Ujud, Deeny Robeatul Adawiyah binti Khairul Anuar & Norzalina binti Jenal</i>	484
93.	New Fundamental Theory in Solving the Royalty Payment Problem <i>Wan Noor Afifah binti Wan Ahmad & Suliadi Firdaus bin Sufahani</i>	489
94.	Notebookly (A Pageless Notebook) <i>Aimi Natasha binti Rujha, Amani binti Mohamad Soree Awankasim, Muhammad Faiz bin Abdul Hamid & Nur Dania Syahirah binti Mohd Asri</i>	492
95.	Nutritious Digital Menu System for Malaysian Religious Primary School Children: Improving Good Memories <i>Azila M. Sudin, Suliadi F. Sufahani & Mohd A.A. Abdullah</i>	495
96.	Online Games for Learning Lewis Structure <i>Wan Elina Faradilla Wan Khalid, Tuan Sarifah Aini Syed Ahmad, Nor Akmalazura Jani, Rohaiza Saat & Nurazira Mohd Nor</i>	501
97.	Optimal Charging Schedule of Electric Vehicles Using Evolutionary Programming to Minimise Costs <i>Hasmaini Mohamad, Norhasniza Md Razali, Ahmad Farid Abidin, Nur Ashida Salim & Zuhaila Mat Yasin</i>	506
98.	The Smart Attendance of Microsoft Team (SAMT 2021) in an Online Learning Classroom <i>Wan Normila Mohamad & Zahari bin Md Rodzi</i>	511
99.	Penelitian Terhadap Kepelbagaian Fungsi Bandar Kecil Terhadap Penduduk Setempat di Gemas, Negeri Sembilan <i>Natasya Farhana Nazry, Jabil Mapjabil & Farzanna Yashera Abdulla</i>	521

- | | | |
|------|---|-----|
| 100. | Penentuan Kaedah Mengukur Kesanggupan Untuk Membayar (WTP) Dalam Pelancongan
<i>Nabila Farysha Dering & Jabil Mapjabil</i> | 525 |
| 101. | Penentuan Kecenderungan Tingkah Laku Pelancong yang Berkunjung ke Kota Kinabalu – Psikosentrik dan Alosentrik
<i>Farzanna Yashera Abdulla , Jabil Mapjabil & Natasya Farhana Nazry</i> | 531 |
| 102. | Penentuan Kuasa Beli Pengunjung terhadap Perkhidmatan Pelancongan Terpilih di Bandaraya Kota Kinabalu, Sabah
<i>Nurul Izzah Ismail & Jabil Mapjabil</i> | 535 |
| 103. | The Artificial Neuron Network for Photocatalytic Degradation of Acid Orange 7 Using Cerium Oxide (CeO ₂)
<i>Wan Nur'ain Awanis binti Wan Sa'ari, Vicinisvarri Inderan, Syahrul Fithry bin Senin & Nur Fadzeelah Abu Kassim</i> | 539 |
| 104. | Perception of Digital Reading Material for Academic Purposes among UMK Undergraduates
<i>Noor Syamimie Mohd Nawi, Lena Ramamurthy, Syakirah Shafien, Suhaida Omar & Nik Ahmad Farhan bin Nik Azim</i> | 544 |
| 105. | Perception of Language Awareness through Framagram: A Classroom Example
<i>Nik Ahmad Farhan bin Azim @ Nik Azim, Lena A/P Ramamurthy, Syakirah binti Shafien, Noor Syamimie binti Mohd Nawi & Shahidatul Maslina binti Mat So'od</i> | 548 |
| 106. | Perkasa @ Aps : Solusi kepada Kerapuhan Keluargayang Mempunyai Anak Cerebral Palsy
<i>Wan Rohila Ganti binti Wan Abdul Ghapar, Muhamad Fazil Ahmad, Norhashimah Yahya & Rahaya Mat Jamin</i> | 552 |
| 107. | Poket Peka Undang-Undang Dilettante V2:Pemberhentian Kerja
<i>Suria Fadhillah Md Pauzi, Muhammad Asyraf Azni, Suriyati Ujang, Azniza Ahmad Zaini & Ida Rosnita Ismail</i> | 556 |
| 108. | Power Generation Using Thermoelectric Power Generator with Parabolic Solar Concentrator
<i>Aneurin Nanggar anak Nyandang, Ir. Dr. Ts. Baljit Singh A/L Bhathal Singh & Dr. Muhammad Fairuz bin Remeli</i> | 562 |
| 109. | Prediction of Nanostructure of SnO ₂ Properties Using Artificial Neural Networks
<i>Khadijah binti Mohd Suhami, Vicinisvarri Inderan, Syahrul Fithry bin Senin & Lee Hooi Ling</i> | 565 |
| 110. | Product Development - e-Ta'awun PA Takaful+
<i>Mohd Faizan bin Mohd Afandi, Norazrisham bin Shamsuddin ,Muhamad Izmul Nizam bin Zubairi , Mohammad Firdaus bin Mohammad Hatta & Mohamad Nizam bin Jaafar</i> | 570 |

111. Promoting Malayan Emergency State by Using Gaming Platform as An Illustrative Medium 577
Mohammad Nor bin Anwar Hussin
112. ProTecME 583
Rosuzeita Fauzi, Syazwan Firdaus Abu Bakar, Roslinda Isa, Siti Nor Ismalina Isa, Diana Tasha Mohd Nazeri
113. Protein as the Building Blocks of Life 587
Rania Farzana binti Azmi, Azleen Nurkarmilya binti Azami, Nur Shafinaz binti Mohamad Salin & Wan Mazlina Md Saad, PhD
114. Pull Up Crisp Container 589
Mohamad Firdaus bin Shaari, Kamarul Asyraf bin Shamsudin & Nurul Fatimah binti Mohamad Azmi
115. RE Protect-i 592
Mohd Azeem bin Ahmad Zaini, Farid Akmal bin Fadzli, Mohd Saiful Izzat bin Mat Zahari, Wahida binti Ahmad & Mohammad Firdaus Mohammad Hatta
116. ReProDB Web Application (Research Project Database) 598
Jennifah Nordin, Afida Arapa, Ibiاناflorinciliana Niane Anthony Aning & Intan Syahriza Azizan
117. Rizbrunana: Advances in High-Fibre Biscuit Using Brown Rice and Banana Peel 609
Nurul Hafizah Mohd Yasin, Derweanna Bah Simpong, Nur Farihin binti Abd Hadi Khan & Mazne Ibrahim
118. Ready-To-Bake (RTB) Cookie Dough 615
Muna Shakirah Bt Mohamad, Norhidayah Bt Abdullah & Nursyadah Bt Nordin
119. RTGreenmFUND: Sejauhmanakah Keberkesanannya dalam Pengurusan Dana Ruang Terbuka Hijau Bandar 618
Nabilaa Mohamed, Thenmolli Vadeveloo, Zarina Mohd Zain & Roni Ekha Putera
120. TCD (Table Connector Design) 622
Ramlan Mustapha, Maziah Mahmud, Surita Hartini Mat Hassan, Siti Norma Aisyah Malkan & Nurul Hidayah Che Hassan
121. Self-Practice Ringkasan (SPRing): An Innovative Mobile Apps for Self-Practice 629
Asmahani Mahdi, Zubaidah Bohari, Abdul Hadi Abdul Talip, Nurul Lizzan Kamarudin & Zainon Haji Bibi

122. Revitalising Heritage Shophouses of Kota Bharu Kelantan 633
Yasmin Mohd Faudzi, Najah Md Alwi, Nor Hafizah Anuar, Juliza Mohamad & Nik Nurul Hana Hanafi
123. Smart 3-Wheel Bike “Empower Disabled Entrepreneurs With Technology” 638
Nurnaddia Nordin, Nurhaiza Nordin & Nur Ilyana Amiira Nordin
124. Takaful Sinar Ihsan Plus 642
Nur Adibah binti Ab Aziry, Erlyn Marlina binti A.Rahman, Nurul Izzaty binti Mohamad Ridzuan & Mohammad Firdaus Mohammad Hatta
125. Smart Keychain 648
Mohd Hifadzly bin Husrin, Adeylson Ray Douni, Muhammad Azlan bin Moh Sali & Edrin Rosley
126. Secured Multi Door Access System as A Web Application 652
Nor Shamshillah Kamarzaman, Norhayati Abdul Jamil, Noraliza Azizan, Jaaz Suhaiza Jaafar & Muhamad Syafiq Ahmad Nazri
127. Standard of Care Framework for Occupier During Pandemic Covid-19 (SOCO): A Facilitation for Understanding Law Relating to Tourism Industry 657
Mohamad Sahizam Musa, Suria Fadhillah Md Pauzi, Shamsinar Abdul Rahman, Mohd Azim Zainal & Ida Rosnita Ismail
128. Development Of Sound System Level Tools “SoQMeT” 664
Muhammad Danial bin Abu Hanafiah, Muhammad Aleef bin Mohamad Yaziz, Muhammad Aiqal bin Mohd Sazali, Adhilla binti Ainun Musir, Nurulzatushima binti Abdul Karim & Daliah binti Hasan
129. Stackable Pinewood Pallet Storage Keeper (SPPiKe) 670
Nurrohana Ahmad, Hazlin Hasan, Sharifah Norhuda Syed Wahid, Mohd Aidil Riduan Awang Kader & Mastura Mohamad
130. Sustainable Hybrid G-W Filter 676
Nur Fatin Nasuha Mhd Khatif, Fahda Nurhani Ahmad Razan, Ir. Nur Azwa Muhamad Bashar & Nurakmal Hamzah
131. Takaphone Takaful 681
Muhammad Waizzulhakim bin Othamannor, Mohd Mazwan bin Mohd Jamil, Mohammad Firdaus bin Mohammad Hatta & Sharifah Faigah binti Syed Alwi
132. Stay@Rural Application 686
Muhammad Faezzul Farhan bin Yazid, Muhammad Hakim Zulqarnain bin Ajis, Mohamad Sazlyzam bin Ledei Dawin@Salim Dawin, Mohd Ashnawi bin Ab Gani & Dr. Spencer Hedley Mogindol

133. Sajadah Pillow 689
Nor Asyiqin Nadhirah binti Roslee Afendi, Sharifah Hafiza binti Abu Bakar, Nur Khaleqa Izzah binti Ikmal Hisam & Siti Hajar binti Md Shahar
134. Pepper Casenitizer 693
Nurfatihah Syahirah binti Zaidi Rahimy, Syahira Nisha Nabila binti Mohamad Shahril, Muhammad Afiq Syahmi bin Rosli, Nur Wani Syamimi binti Yaman & Alvin Gatu
135. My_Watch - Changing the Way We Use Watches 699
Nur Athilla binti Alimin, Nur Hadirah Faqihah binti Zainudin, Siti Nadiah Afiqah binti Suhairi, Joseph Joshua Rumpungan Jr & Adrianna binti Aziz
136. Myeco Application 704
Izz Fitri bin Hairul Sham, Nur Syahirah binti Dzulkarnain , Rosseryn Soubin Lonsiong & Siti Zuraini binti Ramley Alan
137. Multipurpose Pushcart 709
Farah Adlyna Yeoh , Noor Zizy Ameleena binti Jailani , Nur Amiratul Atiqah binti Nur Azli Yaacob & Sairah Saien
138. Multipurpose Handle Stabilizer – To Help You Handle Your Life 714
Nur Athilla binti Alimin, Nur Hadirah Faqihah binti Zainudin, Siti Nadiah Afiqah binti Suhairi, Joseph Joshua Rumpungan Jr & Adrianna Aziz
139. The Travel Amenity Pod 719
Wan Nuramalin binti Wan Hussin, Nur Alissya binti Nazri, Muhammad Takhir bin Arifuddin & Ahmad Fareez bin Yahya
140. Toothbrush 2-In-1 724
Alice Evana Anak Robert, Latijah Obaun, Staffy Stephen & Christy Bidder
141. Torch Bottle 727
Muhammad Shazwan Puzi, Farzana Suaidah binti Suzaini, Nurul Aina Balqis binti Mohd Khairul Anuar & Nur Murniza binti Mohd Zaidi
142. Tourism Application - Touch 731
Siti Hafizah binti Dzulkarnain, Amira Naqiyyah binti Mustaffa Ma'arof , Nursyahidah binti Hamzah, Nur Hidayah binti Mohammad Hazlan & Boyd Sun Fatt
143. Locallah 736
Muhammad Faliq Aizat M.Amran, Nazmeen Fatima binti Istekhar Ahmad, Nur Izzati Nabilah binti Alias, Adriana binti Mohamad Faizal & Mohd Arsy Ardy bin Mohd Hardy
144. Ez-Train Mobile App 741
Siti Aishah binti Sha'ari, Alirah Itor, Muhammad Faizzudin bin Mohd Shukor, Nur Hazeera binti Madehie & Nurafiqah binti Mohamad Musa

145. Eventgo 747
Cassandra Grace anak Hamarah, Nazira Farahin binti Nazarudin, Venessa Kumang Amen anak Victor Luna & Cindy Johnny
146. Duo-Bottle 752
Maybelyna Deborah Dick, Nurashikin Binti Hamzah, Jacqueline Henry & Nurafiqah Binti Mohamad Musa
147. 4 In 1 Safety Kit 755
Nur Maisarah Afiqah binti Mazlan, Aina Afriena binti Afandi, Aida Najihah binti A.Lukman, Muhammad Irfan bin Mazlan & Nur Murniza binti Mohd Zaidi
148. Augmented Reality Design: The Study of Property Development Marketing Tools 761
Norzaful Anuwar bin Ahmad Najamuddin
149. SMART Hygiene Kit 765
Dg Kamisah Ag Budin, Jasmine Vivienne Andrew, Faiqah Mawardi, Mohammad Firdaus bin Mohamad & Dayang Haryani Diana Ag Damit

EARLY FLASH FLOOD DETECTION AND AVOIDANCE SYSTEM

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ABSTRACT

In Malaysia, flash floods are common occurrences throughout the year and commonly occur in urbanized areas. Flash floods are mostly caused by the seasonal monsoon rain when inadequate drainage systems are unable to channel the water flow properly. The overflow of the rivers is also a major reason for occurring flash floods in the city. Late detection of this disaster may cause damage to property and infrastructure, disrupts the traffic flow, endangering human life, psychological impact to the user etc. This project is to detect a flash flood and avoidance system that aims to detect heavy rainfall followed by detecting high water level at the specified area. The system works as an indicator that will give an early warning to users and as an avoidance system that controls the flood basin gate when flood is high. This project uses Arduino UNO as a microcontroller, Ultrasonic Sensor and rain sensor as an input, and global system for mobile communication (GSM) module, buzzer, motor and liquid-crystal display (LCD) as the output of the system. A GSM is used to alert the flood condition to the user and rescue team by transmitting the water level condition measured by ultrasonic sensor. With this reliable detection system, the flash flood in urban areas can be avoided by users and authorities at an early stage. Consequently, the infrastructure damage and psychological impact to people can be minimized.

Keywords: Flash flood, rain detection, water level detection, GSM

INTRODUCTION

Floods in Malaysia can be categorized into monsoon floods and flash floods. Flash floods usually occur in areas with rapid development by a rapid rise in water level, high velocity, and large amounts of debris. This disaster is mostly caused by the seasonal monsoon rain when

inadequate drainage systems are unable to channel the water flow properly. This project will work as a flood monitoring system which is one of the technologies that can be used to prevent loss in places where floods always occur such as in Kuala Lumpur, Selangor and Penang. This project will be placed at the urban area to alert the surroundings to evacuate or to inform people about the road with flood. This project will be placed near the neighborhood or town to alarm the surroundings to evacuate. This project used an ultrasonic sensor as the input to measure the height of the water, rain sensor to notify the user if it is raining, GSM to send notification, and a siren and motor to open the gate to let the water flow into the flood basin.

This project focuses on the city that is affected by rivers or drains that are the main cause of flash floods in Malaysia. This project will be developed using an ultrasonic sensor to monitor the water level thus determining whether it is necessary to operate the motor and a rain sensor to monitor the weather. This project uses Arduino, which requires programming, a motor to control the flow of the water, a siren and utilizes GSM to transmit the message.

METHODOLOGY

The prototype design of the flood detection system is built by integrating 6 components such as the system block diagram in Figure 1. It is seen that in the input section there is an input section consisting of an ultrasonic sensor and rain sensor, while on the controller part, there is Arduino Microcontroller and in the output part there is DC Motor, siren and GSM.

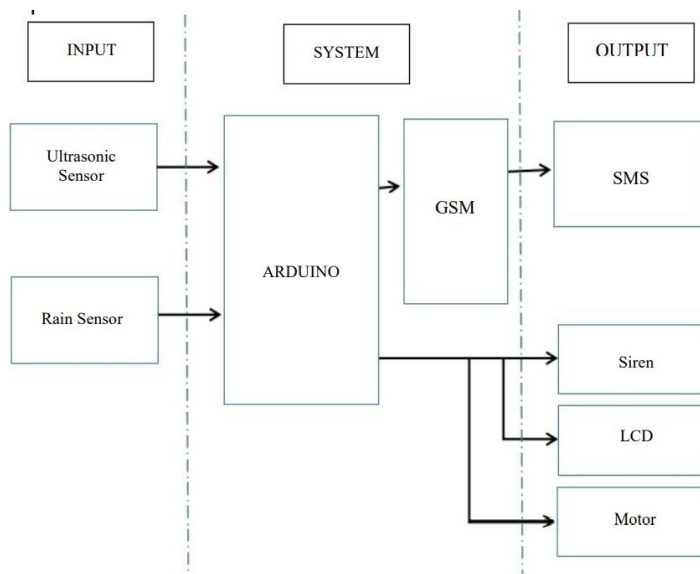


Figure 1. Block Diagram of flood detection and avoidance

The information from the input will be sent to Arduino for the decision process. This component in the system communicates with each other by using the programming code in the Arduino controller. In this system, there are two DC motors needed to operate the flood basin gate. The output will be activated when water reaches the danger level which is measured from the surface of the water to the ultrasonic sensor.

Flowchart of the system is structured as in Figure 2. It starts with the system detecting the

rainwater that will cause flash floods. Once the rainwater is detected, the LCD will display the rain status and the GSM module will send a message to the user. For the flood detection part, it is divided into two parts, low level and high (danger) level. If the water level is in low condition, it means the water level is harmless and the system is in power save mode. If the water level is high (10cm or lower from water surface to the sensor) it means the water level is dangerous to people and the system will proceed to evacuation procedure while the motor and buzzer are activated simultaneously. The ultrasonic sensor setup to the water surface is shown in Figure 3.

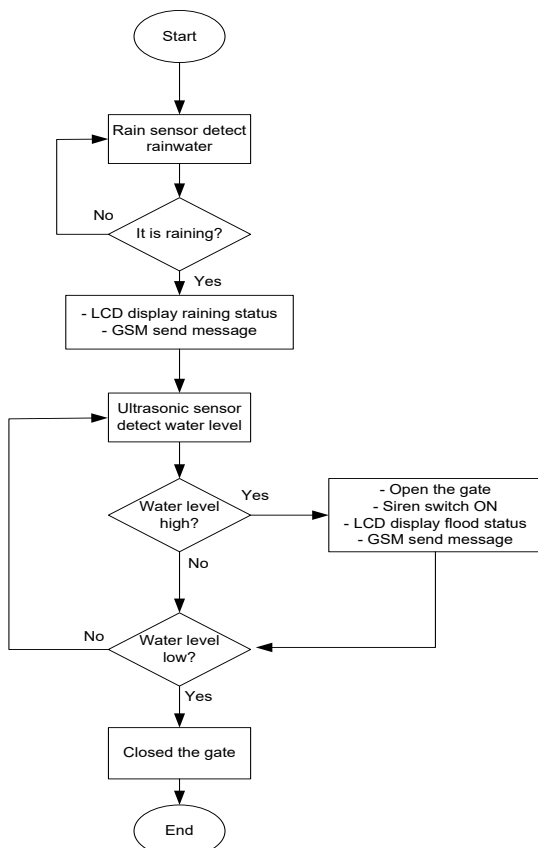


Figure 2. Flow chart

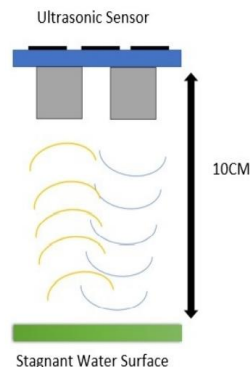


Figure 3. Ultrasonic sensor setup from water surface

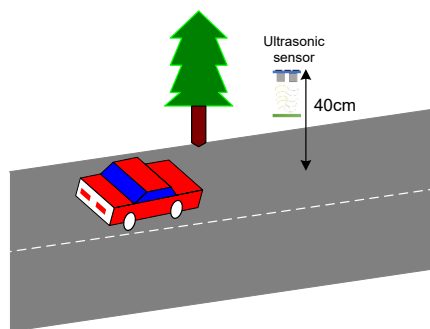


Figure 4. Ultrasonic sensor setup from water surface to road

Table 1. shows the water level status and flood condition based on the distance setup from ultrasonic sensor to the water surface. In this prototype, the ultrasonic sensor is placed 40cm from the road as in Figure 4. Meanwhile in the programming, 0 to 10cm distance water surface to ultrasonic sensor is set as HIGH level status (danger condition) and the distance greater than 10cm is set as LOW level (safe condition).

Table 1. Water level status and flood condition

Distance from water surface to ultrasonic sensor	Distance from road to ultrasonic sensor	Water level status	Condition of flood
0 -10cm	40cm	High	Danger
More than 10cm	40cm	Low	Safe

RESULT

Simulation Result

Figure 5 shows a schematic diagram of the system using the Proteus simulation. Due to lack of components in the Proteus simulation library, the siren is replaced by the buzzer, the rain sensor is replaced by logic toggle and the GSM module is replaced by the serial monitor. For the rain sensor, the logic toggle will switch to logic '1' when water is detected and '0' for no water detected.

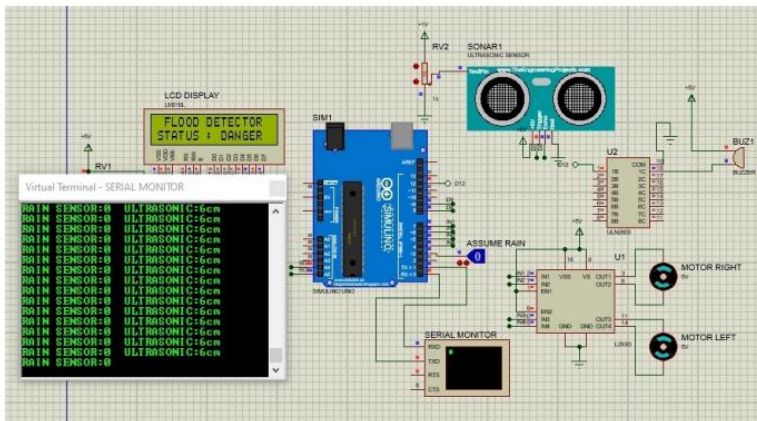


Figure 5. Schematic diagram

When the rain sensor senses rainwater, it will activate two outputs which are the LCD and GSM module. The LCD will show “Raining Day”. The GSM module will send a message “Raining Day !!! beware” to the user and authorities. The Ultrasonic sensor will measure water level (if less than 10cm) and activate four outputs - buzzer, DC motor, LCD and GSM module as in Figure 4. 10cm is the maximum value for ultrasonic to sense the Danger condition. The LCD will display “DANGER” in the second row. The buzzer will switch ON and the motor will operate clockwise (gate open) to allow stagnant water to flow into the flood basin.

Hardware Result

Hardware result is focusing on assembling all the components which are the two input sensors; the rain sensor and the ultrasonic sensor and four output; GSM module, 16X2 LCD, two DC motors and buzzer as in Figure 6. All the assembling process must refer to each component data sheet. After finishing the assembling process, proceed to the next step which is to make a prototype with the main material from PVC pipe, used box, plastic food container and plastic

water container. The PVC pipe and plastic water container construction represent the gate that allows stagnant water to flow into the flood basin.

When the rain sensor senses rainwater, it will activate two outputs which are the LCD and GSM module. The measured voltage and current when the rain sensor detects rainwater are 5V and 0.25A. Meanwhile, voltage for GSM module and LCD display are 4.1V and 5V respectively. The GSM module will send the message “RAINING!!! Beware” to the user and the LCD will show “RAINING”.



Figure 6. Complete prototype

Table 2. LCD Display and DC motor movement result

Distance from water surface to ultrasonic sensor (cm)	LCD Display (2 nd row)	DC motor movement
2	DANGER	Clockwise
4	DANGER	Clockwise
6	DANGER	Clockwise
8	DANGER	Clockwise
10	DANGER	Clockwise
12	NORMAL	Anticlockwise
14	NORMAL	Anticlockwise
16	NORMAL	Anticlockwise
18	NORMAL	Anticlockwise
20	NORMAL	Anticlockwise
22	NORMAL	Anticlockwise
24	NORMAL	Anticlockwise

Table 2 shows the result of LCD display and DC motor movement when the distance 2 to 24 cm from water surface to ultrasonic sensor. For the distance from 2 to 10 cm, the DC motor movement is clockwise to open the gate for water to flow into the flood basin. While for the distance from 12 to 24 cm, the DC motor movement is anti clockwise to close the gate.

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