



The 6th International Conference on Information Technology (InCIT 2022)



10th-11th NOVEMBER 2022

@PANYAPIWAT INSTITUTE OF MANAGEMENT (PIM)
NONGTHABURI, THAILAND

MESSAGE FROM GENERAL CHAIR

On behalf of the CITT Association, it is our great honor to welcome you to the 6th International Conference on Information Technology (InCIT 2022) at Panyapiwat Institute of Management (PIM) in Nonthaburi, Thailand.

InCIT is an essential forum for researchers to discuss the state-of-the-art and future trends of related technology and exchange experiences. Hence, we encourage delegates to participate actively in the sessions and discussions ahead during the conference days.

On behalf of the CITT Association, we would like to thank the international coordinators, advisory committees, organizing committees, program chairs, and reviewers who voluntarily invested their time in selecting papers and arranging such a successful conference. We wish everyone a happy time with this successful and fruitful conference and enjoy their stay in Thailand.

We would like to express our gratitude to all committee members for their devotion and hard work to make this truly successful conference. Finally, we wish you all the inspiring discussions and enjoy your time along with cordial and sincere friendship at InCIT2022, Thailand.

Thank you very much.



Assoc.Prof. Pisit Charnkeitkong , D.Eng.

InCIT2022 General Chair

President of CITT Association

Panyapiwat Institute of Management

MESSAGE FROM TECHNICAL PROGRAM CHAIR

On behalf of the technical program committee (TPC), we would like to deeply thank all participants and it is our great pleasure to welcome you to the 6th International Conference on Information Technology (InCIT 2022).

We are very excited about the technical program that brings together many high-quality papers from many countries, more than hundred contributed papers that were submitted to our conference in this year. Our team which consists of TPCs and reviewers has worked hard to complete the process of peer review and selection. Each paper received comments from the respective research community. In addition, there are three keynote and three invited speakers who contribute in this conference. Consequently, the conference program has about hundred papers from various universities and institutions including both onsite and online sessions.

Finally, we would also like to express our deepest gratitude to all committee members and session chairs who voluntarily invest their own time in selecting papers and arranging such a successful and memorable conference. We hope you enjoy the technical program and that while at the conference you can take advantage of the excellent chance to exchange ideas with other researchers and practitioners, and also initiate some fruitful collaboration between universities or institutions. Welcome you all to PIM, Thailand.

Thank you very much.



Datchakorn Tancharoen, Ph.D.

Technical Program Chair

Panyapiwat Institute of Management

TABLE OF CONTENTS

MESSAGE FROM GENERAL CHAIR.....	I
MESSAGE FROM TECHNICAL PROGRAM CHAIR.....	II
TABLE OF CONTENTS.....	III
WELCOME TO InCIT 2022.....	IV
ORGANIZING COMMITTEE.....	VI
ADVISORY COMMITTEE.....	IX
INTERNATIONAL COMMITTEE.....	XI
TECHNICAL PROGRAM COMMITTEE.....	XII
LIST OF REVIEWERS.....	XVI
PROGRAM.....	XXI
PAPER INFORMATION.....	XXIII
ORGANIZERS.....	XXXV
TECHNICAL SPONSORS.....	XXXVII
HOSTS.....	XXXVIII

WELCOME TO InCIT 2022

The 6th International Conference on Information Technology (InCIT2022)

Theme: Digital Technology and Innovation During Education Transformation

Date: 10th-11th November 2022

Venue: Panyapiwat Institute of Management (PIM), Nonthaburi, Thailand

The Sixth International Conference on Information Technology (InCIT2022) is a premier forum for sharing research in areas related to information and communication technologies. We believe that fostering research encompassing intelligent technology and innovation for the future of society is vital. Authors involved in those research areas are cordially invited to submit papers and present them at InCIT2022. The conference will be an ideal opportunity to strengthen collaboration between researchers. It will provide many excellent opportunities for participants to exchange and discuss new innovative ideas and research results, as well as enabling exploration of future directions for cooperative research.

Scope:

- Artificial Intelligence
- Cloud Service and Computing
- Computer Animation and Game
- Database Technology
- Geo-informatics
- IT in Education
- IT Security and Privacy
- Intelligence Communications
- Network Security and Privacy
- Pattern Recognition
- Quantum Computing
- Natural Language Processing
- Smart and Expert Systems
- Wireless and Mobile Networks
- Data Science and Analytics
- Communications and Networking
- Digital Multimedia Technology
- E-Commerce, E-Education, E-Industry, E-Society
- Human Computer Interaction
- IT and Project Management
- IT and Mobile Application
- Internet of Things
- Augmented and Virtual Reality
- Platform Technologies
- Signal Processing
- Bio-medical Informatics
- Web and Internet Technologies
- Other Related Topic

Paper Submission

Full paper submission in English is expected. All manuscripts must be prepared in the standard IEEE Conference Proceedings format and limited to 4-6 pages of A4 form in PDF format. Please use 10 points and Time New Roman font. The authors' names and affiliations, postal addresses, telephones, fax numbers and e-mail addresses must be omitted from the submitted manuscripts. Each manuscript must contain an abstract of about 150 words.

Program Agenda

There are 18 sessions for InCIT2022 delivered by hundreds of national and international speakers. The accepted papers for the conference will be presented as oral presentations on either online or onsite platforms. Both presentations are vital to the success of the conference and are expected to be of similarly high technical quality.

Onsite and Online Oral Presentations

The presenting author or representative must be registered at the Conference and available to provide details and answer questions during the Conference. The presentation has a 12-minute talk by the registered author, followed by a 3-minute discussion period for in-person attendees.

ORGANIZING COMMITTEE

Honorable Chairs

- Kiyoharu Aizawa, U-Tokyo, Japan
- Yo-Sung Ho, GIST, Korea
- Chai Wultiwiwatchai, NECTEC
- Pongsakorn Yuthagovit, PEA / IEEE THAILAND
- Ruttikorn Varakulsiripunth, TNI / CITT
- Supot Tiarawut, DGA

General Chair

- Pisit Charnkeitkong, PIM
President, Council of IT Deans in Thailand (CITT)

General Co-Chairs

- Sunantha Sodsee, KMUTNB
- Teeravisit Laohapensaeng, MFU
- Thanaruk Theeramunkong, TU / AIAT
- Vuttipong Areekul, KU / ECTI

Technical Program Chair

- Datchakorn Tancharoen, PIM

International Program Co-Chairs

- Mitsunori Makino, Chuo University, Japan
- Kwang-Hyun Baek, Chung-Ang University, Korea
- Wu-Yuin Hwang, National Central University, Taiwan

Technical Program Co-Chairs

- Krisana Chinnasarn, BUU
- Sakchai Tangwannawit, KMUTNB
- Thepchai Supnithi, NECTEC
- Worasak Rueangsirarak, MFU

Publication Co-Chairs

- Aziz Nanthaamornphong, PSU
- Annop Monsakul, PIM
- Adisorn Kheaksong, PIM
- Kaboon Thongtha, MUT

Publicity Co-Chairs

- Duangjai Jitkongchuen, DPU
- Watchareewan Jitsakul, KMUTNB
- Lapas Pradittasnee, KMITL

Registration Co-Chairs

- Nonchanutt Chudpooti, KMUTNB
- Pakapan Limtrairut, BU
- Phattanapon Rhienmora, BU
- Wanvipa Wongvilaisakul, PIM

Industrial Relation Co-Chairs

- Dechanuchit Katanyutaveetip, SU
- Rattana Wetprasit, PSU
- Pruegsa Duangphasuk, RV Connex

Special Session Co-Chairs

- Chetneti Srisaan, RSU
- Jian Qu, PIM
- Krishna Chimmanee, RSU
- Sakorn Mekruksavanich, UP
- Surapong Uttama, MFU
- Warodom Werapun, PSU

Local Arrangement Co-Chairs

- Parinya Sanguansat, PIM
- Phannachet Na Lamphun, PIM
- Nivet Chirawichitchai, PIM

Activity Co-Chairs

- Nuchanat Buasri, MSU
- Pornsak Preeleka, PIM
- Suppat Rungraungsilp, WU

General Secretary

- Suamporn Pansup, PIM

Webmaster

- Woottikarn Hongwiengchan, PIM

ADVISORY COMMITTEE

- Adisak Suasaming,
Thai-Nichi Institute of Technology (TNI)
- Aziz Nanthaamornphong,
Prince of Songkla University Phuket Campus (PSU)
- Chaiyaporn Khemapatapan,
Dhurakij Pundit University (DPU)
- Chetneti Srisaan,
Rangsit University (RSU)
- Dechanuchit Katanyutaveetip,
Siam University (SiamU)
- Jaroensri Mitrpanont,
Mahidol University (MU)
- Khajit Na Kalasin,
Nakhon Phanom University (NPU)
- Kriengkrai Porkaew,
King Mongkut's University of Technology Thonburi (KMUTT)
- Krisana Chinnasarn,
Burapha University (BUU)
- Kosin Chamnongthai,
King Mongkut's University of Technology Thonburi (KMUTT)
- Nathaporn Karnjanapoomi,
Silpakorn University (SU)
- Nipon Charoenkitkarn,
King Mongkut's University of Technology Thonburi (KMUTT)
- Panavy Pookaiyaudom,
Mahanakorn University of Technology (MUT)
- Pattanapon Rhienmora,
Bangkok University (BU)
- Pattanasak Mongkolwat,
Mahidol University (MU)
- Pisit Charnkeitkong,
Panyapiwat Institute of Management (PIM)
- Poonpong Boonbrahm,
Walailak University (WU)

- Pornthep Rojanavasuu,
University of Phayao (UP)
- Ruttikorn Varakulsiripunth,
Thai-Nichi Institute of Technology (TNI)
- Sasitorn Keawmun,
Mahasarakham University (MSU)
- Sinchai Kamolphiwong,
Prince of Songkla University Phuket Campus (PSU)
- Siridech Boonsang,
King Mongkut's Institute of Technology Ladkrabang (KMITL)
- Sujin Butdisuwan,
Mahasarakham University (MSU)
- Sunantha Sodsee,
King Mongkut's University of Technology North Bangkok (KMUTNB)
- Supawee Makdee,
Ubon Ratchathani University (UBRU)
- Thana Sukvaree,
Sripatum University (SPU)
- Thirapon Wongsardsakul,
Bangkok University (BU)
- Weresak Kurutach,
Mahanakorn University of Technology (MUT)

INTERNATIONAL COMMITTEE

- Atsuo Ozaki, Osaka Institute of Technology, Japan
- Ambar Bajpai, Atria Institute of Technology, India
- Byung Cheol Song, Inha University, Korea
- Hiroshi Kera, Chiba University, Japan
- Jong-Ok Kim, Korea University, Korea
- Kiyoharu Aizawa, The University of Tokyo, Japan
- Khanthanou Luangxaysana, National University of Laos, Laos
- Kwang-Hyun Baek, Chung-Ang University, Korea
- Mitsunori Makino, Chuo University, Japan
- Manik Sharma, DAV University, India
- Masaki Ogura, Osaka University, Japan
- Masaki Umejima, Keio University, Japan
- Muhammad Saadi, University of Central Punjab, Pakistan
- Orland Delfino Tubola, Polytechnic University of the Philippines
- Ridwan Sanjaya, Soegijapranata Catholic University, Indonesia
- Rustam Shadiev, Nanjing Normal University, China
- Shigemasa Takai, Osaka University, Japan
- Takashi Yukawa, Nagaoka University of Technology, Japan
- Thelma Domingo-Palaoag, University of the Cordilleras, Philippines
- Toshihiko Yamasaki, The University of Tokyo, Japan
- Virach Sornlertlamvanich, Musashino University, Japan
- Worrawat Engchuan, The Centre for Applied Genomics, Canada
- Wu-Yuin Hwang, National Central University, Taiwan
- Yo-Sung Ho, Gwangju Institute of Science & Technology, Korea
- Yoshihiro Kaneko, Gifu University, Japan

TECHNICAL PROGRAM COMMITTEE

- Atsuo Ozaki,
Osaka Institute of Technology, Japan
- Ambar Bajpai,
Atria Institute of Technology, India
- Byung Cheol Song,
Inha University, Korea
- Hiroshi Kera,
Chiba University, Japan
- Jong-Ok Kim,
Korea University, Korea
- Kiyoharu Aizawa,
The University of Tokyo, Japan
- Khanthanou Luangxaysana,
National University of Laos, Laos
- Kwang-Hyun Baek,
Chung-Ang University, Korea
- Mitsunori Makino,
Chuo University, Japan
- Manik Sharma,
DAV University, India
- Masaki Ogura,
Osaka University, Japan
- Masaki Umejima,
Keio University, Japan
- Muhammad Saadi,
University of Central Punjab, Pakistan
- Orland Delfino Tubola,
Polytechnic University of the Philippines
- Ridwan Sanjaya,
Soegijapranata Catholic University, Indonesia
- Rustam Shadiey,
Nanjing Normal University, China
- Shigemasa Takai,
Osaka University, Japan

- Takashi Yukawa,
Nagaoka University of Technology, Japan
- Thelma Domingo-Palaoag,
University of the Cordilleras, Philippines
- Toshihiko Yamasaki,
The University of Tokyo, Japan
- Virach Sornlertlamvanich,
Musashino University, Japan
- Worrawat Engchuan,
The Centre for Applied Genomics, Canada
- Wu-Yuin Hwang,
National Central University, Taiwan
- Yo-Sung Ho,
Gwangju Institute of Science & Technology, Korea
- Yoshihiro Kaneko,
Gifu University, Japan
- Annop Monsakul,
Panyapiwat Institute of Management (PIM)
- Boonsit Yimwadsana,
Mahidol University (MU)
- Chantri Polprasert,
Srinakharinwirot University (SWU)
- Chakchai So-In,
Khon Kaen University (KKU)
- Datchakorn Tancharoen,
Panyapiwat Institute of Management (PIM)
- Duangjai Jitkongchuen,
Dhurakij Pundit University (DPU)
- Jitti Sampattakul,
Royal Thai Naval Academy (RTNA)
- Kaboon Thongtha,
Mahanakorn University of Technology (MUT)
- Khanthanou Luangxaysana,
National University of Laos (NUL)
- Lapas Pradittasnee,
King Mongkut's Institute of Technology Ladkrabang (KMITL)

- Lunchakorn Wuttisittikulij,
Chulalongkorn University (CU)
- Nathaporn Utakrit,
King Mongkut's University of Technology North Bangkok (KMUTNB)
- Nathaporn Karnjanapoomi,
Silpakorn University (SU)
- Nuchanat Buasri,
Mahasarakham University (MSU)
- Pakapan Limtrairut,
Bangkok University (BU)
- Parkpoom Chaisiriprasert,
Rangsit University (RSU)
- Parinya Sanguansat,
Panyapiwat Institute of Management (PIM)
- Pawitra Chiravirakul,
Mahidol University (MU)
- Pirapat Chantron,
Sripatum University (SPU)
- Piya Kovintavewat,
Nakhon Pathom Rajabhat University (NPRU)
- Pornyos Maneechopteeti,
Silpakorn University, Petchburi IT Campus (SU)
- Prajaks Jitngernmadan,
Burapha University (BUU)
- Pramuk Boonsieng,
Thai-Nichi Institute of Technology (TNI)
- Rattana Wetprasit,
Prince of Songkla University Phuket Campus (PSU)
- Rawiworn Hongma,
Nakhon Phanom University (NPU)
- Sakchai Tangwannawi,
King Mongkut's University of Technology North Bangkok (KMUTNB)
- Sakorn Mekraksawanit,
University of Phayao (UP)
- Saowaluk Thaiklang,
Ubon Ratchathani University (UBRU)

- Songsri Tangsripairoj,
Mahidol University (MU)
- Supavadee Aramvith,
Chulalongkorn University (CU)
- Suppat Rungraungsilp,
Walailak University (WU)
- Suree Funilkul,
King Mongkut's University of Technology Thonburi (KMUTT)
- Suvit Poomrittigul,
Pathumwan Institute of Technology (PIT)
- Teerapol Silawan,
Chulalongkorn University (CU)
- Ungsumalee Suttapakti,
Burapha University (BUU)
- Waraporn Jirapanthong,
Dhurakij Pundit University (DPU)
- Warakorn Srichavengsup,
Thai-Nichi Institute of Technology (TNI)
- Warodom Werapun,
Prince of Songkla University Phuket Campus (PSU)
- Watchareewan Jitsakul,
King Mongkut's University of Technology North Bangkok (KMUTNB)
- Worasak Rueangsirarak,
Mae Fah Luang University (MFU)

LIST OF REVIEWERS

- Adisak Suasaming
- Akadej Udomchaiporn
- Alisa Kongthon
- Amnuay Sala
- Ananta Srisuphab
- Annop Monsakul
- Anon Sukstrienwong
- Apichat Suratane
- Apichaya Nimkoompai
- Apirak Hoonlor
- Arit Thammano
- Athitaya Nitchot
- Auttapon Pomsathit
- Aziz Nanthaamornphong
- Chakchai So-In
- Chanakarn Kingkaew
- Chanankorn Jandaeng
- Charlee Kaewrat
- Chayapol Kamyod
- Chetneti Srisaan
- Chutima Beokhaimook
- Datchakorn Tancharoen
- Dechanuchit Katanyutaveetip
- Duangjai Jitkongchuen
- Ferdin Joe John Joseph
- Hanmin Jung
- Jantana Panyavaraporn
- Jaree Thongkam
- Jian Qu
- Jirawut Benjanarasut
- Kaboon Thongtha
- Kanjana Laosen
- Kanokwan Sitthithakerngkiet

- Karn Yongsiriwit
- Kasem Thiptarajan
- Kemachart Kemavuthanon
- Khwunta Kirimasthong
- Konlakorn Wongpatikaseree
- Korawit Prutsachainimmit
- Kreangsak Tamee
- Kriengsak Treeprapin
- Krisda Lengwehasatit
- Krishna Chimmanee
- Kunagorn Kunavut
- Kwankamon Dittakan
- Lin Myint
- Mahamah Sebakor
- Nacha Chondamrongkul
- Narit Hnoohom
- Narong Chaiwut
- Narong Mettripun
- Narongdech Keeratipranon
- Narongsak Putpuek
- Nattagit Jiteurtragool
- Nattakarn Phaphoom
- Nattapol Aunsri
- Nattapong Tongtep
- Nikorn Rongbutsri
- Nilubon Kurubanjerdjit
- Nutthanon Leelathakul
- Paitoon Rukluer
- Pakapan Limtrairut
- Papangkorn Pidchayathanakorn
- Paramate Horkaew
- Parinya Sanguansat
- Parkpoom Chaisiriprasert
- Paskorn Apirukvorapinit
- Patcharaporn Panwong

- Paweena Suebsombut
- Peraphon Sophatsathit
- Petcharat Suriyachai
- Phattanapon Rhienmora
- Pikul Vejjanugraha
- Piya Kovintavewat
- Piyanuch Silapachote
- Porawat Visutsak
- Pornavalai Chotipat
- Pornchai Mongkolnam
- Pornthep Rojanavasud
- Prajaks Jitngernmadan
- Pramuk Boonsieng
- Pranisa Israsena
- Prasara Jakkaew
- Preecha Kocharoen
- Preecha Tangworakitthaworn
- Pruegsa Duangphasuk
- Ratchasak Somyanonthanankul
- Rojanee Khummongkol
- Sakchai Tangwannawit
- Sakorn Mekruksavanich
- Salil Boonbrahm
- Sanpawat Kantabutra
- Sansanee Auephanwiriyaikul
- Santichai Wicha
- Sapransit Mruetusatorn
- Sarayut Nonsiri
- Silada Intarasothonchun
- Sirikan Chucherd
- Siriwatchana Kaeophanuek
- Somchai Lekcharoen
- Songphan Choemprayong
- Songsri Tangsripairoj
- Soontarin Nupap

- Srisupa Palakvangsa-Na-Ayudhya
- Sujitra Arwatchananukul
- Sukanya Phongsuphap
- Sukumal Kitisin
- Sumeth Yuenyong
- Sunisa Rimcharoen
- Supaporn Bunrit
- Supaporn Chairungsee
- Suparek Janjarasjitt
- Supatana Auethavekiat
- Suppakarn Chansareewittaya
- Suppat Rungraungsilp
- Surapong Auwatanamongkol
- Surapong Utama
- Surasak Mungsing
- Sureeluk Weerajong
- Suthanya DOUNG-IN
- Suvit Poomrittigul
- Teerapol Silawan
- Teerawat Kamnardsiri
- Thana Udomsripaiboon
- Thannob Aribarg
- Thara Angskun
- Thawatchai Su
- Thitinan Kliangsuwan
- Thitiporn Lertrusdachakul
- Thongchai Kaewkiriya
- Thongchai Yooyativong
- Udomtipok Phaikaset
- Ungsumalee Suttapakti
- Vanvisa Chutchavong
- Varunyu Vorachart
- Vasaka Visoottiviseth
- Virach Somlertlamvanich
- Vorapoj Patanavijit

- Wacharawan Intayoad
- Waiwit Chanwimalueng
- Waralak Chongdarakul
- Waraporn Jirapanthong
- Warodom Werapun
- Wasara Rodhetbhai
- Watchareewan Jitsakul
- Weerawut Thanhikam
- Wilailak Treepuech
- Wilawan Inchamnan
- Wimalyn Bovenizer
- Wiroon Sriborrirux
- Worapan Kusakunniran
- Worasak Rueangsirarak
- Worawat Choensawat
- Wudhichart Sawangphol
- Yaowadee Temtanapat
- Yasushi Kanazawa
- Yoko Nakajima
- Yootthapong Tongpaeng

PROGRAM

InCIT 2022 Program Schedule 10th November 2022

10 Nov. 2022	Period	Program	Location
	8:00-9:00	Registration	CP ALL Academy
	9:00-9:45	Opening Ceremony - Main room (Hybrid) 📺	Auditorium
	9:45-10:15	Keynote I: Dr.Siwaruk Siwamogsatham Secretary- General of Personal Data Protection Committee	
	10:15-10:30	Break	
	10:30-11:00	Keynote II: Dr.Chawapol Jariyawiroj President, Huawei Technologies Thailand Co.,Ltd.	
	11:00-11:30	Keynote III: Assoc. Prof. Dr.Supavadee Aramvith Vice Chair, IEEE Thailand Section	
	11:30-12:00	Program Introduction	
	12:00-13:00	Lunch Break	Hall 1-2

InCIT 2022 Program Schedule 10th November 2022

10 Nov. 2022	Period	Program			Location	
	12:00-13:00	Lunch Break			Hall 1-2	
	13:00-14:30	Hall 3 - Main room (Hybrid) 📺		Hall 5	Hall 6	PIM Convention Hall
		Invited Speakers		RS1	NCIT1	
		Wu-Yuin Hwang Kwang-Hyun Baek Mitsunori Makino		1570843100	2335	
				1570825805	2977	
				1570835232	3836	
	1570835492			3971		
	1570822745	9730				
	1570852119	244				
14:30-15:00	Break			Hall 1-2		
15:00-16:30	Hall 3	Hall 4	Hall 5	Hall 6	PIM Convention Hall	
	IS1	IS2	RS2	NCIT2		
	1570843075	1570847124	1570845157	2030		
	1570835863	1570847126	1570824071	4379		
	1570844613	1570842902	1570824721	4997		
	1570846052	1570834778	1570835493	5645		
1570822744	1570836548	1570835385	8329			
1570835543	1127					
16:30-17:30	Networking and Activity			Hall 1-2		
17:30-18:00	Transfer Venue			PIM		
18:00-21:00	Welcome Reception			Best Western Hotel		

InCIT 2022 Program Schedule 11th November 2022

11 Nov. 2022	Period	Program				Location
	12:00-13:00	Registration				Hall 1-2
	15:00-16:30	Hall 3	Hall 4	Hall 5	Hall 6	PIM Convention Hall
		SS1	SS2	RS3	NCIT3	
		1570833382	1570836024	1570835562	3510	
		1570844710	1570836075	1570833366	7059	
		1570844721	1570845850	1570835530	8098	
		1570846273	1570845874	1570835752	9249	
		1570821545	1570846151	1570835577	1851	
	1570835724	1570852795	1570835641			
10:00-10:30	Break				Hall 1-2	
10:30-12:00	Hall 3	Hall 4	Hall 5	Hall 6	PIM Convention Hall	
	IS3	SS3	RS4	NCIT4		
	1570845658	1570837890	1570831874	4193		
	1570845219	1570840911	1570845333	5871		
	1570845014	1570846169	1570846110	6559		
	1570845587	1570846224	1570806076	7330		
	1570844962	1570846255	1570846217	7476		
	1570845417	1570848059	1570845922	9309		
12:00-13:00	Lunch / Online Registration				Hall 1-2	

InCIT 2022 Program Schedule 11th November 2022

11 Nov. 2022	Period	Program				Location
	12:00-13:00	Lunch / Online Registration				Hall 1-2
	13:00-14:30	IS4 OL 📺	SS4 OL 📺	RS5 OL 📺	RS6 OL 📺	Online
	14:30-15:00	1570844878	1570830764	1570822758	1570846202	Online
		1570843390	1570839344	1570825500	1570830431	
		1570833512	1570830441	1570826043	1570845580	
		1570846510	1570837340	1570835527	1570845032	
		1570844954	1570833679	1570835140	1570847731	
		1570837190	1570829885	1570826676		
	14:30-15:00	Online Networking – Main room				Online
15:00-16:30	IS5 OL 📺	SS5 OL 📺	RS7 OL 📺	RS8 OL 📺	Online	
15:00-16:30	1570845949	1570849084	1570844973	1570852129	Online	
	1570840929	1570843575	1570835342	1570852148		
	1570840931	1570849406	1570835557	1570852154		
	1570841097	1570845068	1570835921	1570852380		
	1570843309	1570852069	1570844864			
16:30-17:00	Closing Remark - Main room				Online	

PAPER INFORMATION

ID	TITLE	PAGE
1570806076	Lightweight Automatic Business Card Generator Utilizing the Swift Language <i>Pawit Limpasuthum; Datchakorn Tancharoen</i>	1
1570821545	Development of MFU WIFI MAP <i>Suppakarn Chansareewittaya; Korrawit Santithanmanan; Chawarat Bannasak; Anavil Goythong; Mahamah Sebakor</i>	5
1570822744	Seaport Throughput Forecasting by Hybrid Machine Learning Algorithm <i>Hwan-Seong Kim; Truong Ngoc Cuong; Long Le Ngoc Bao; Sam-Sang You; Tae-Woo Lim</i>	10
1570822745	Permutation Invariant Agent-Specific Centralized Critic in Multi-Agent Reinforcement Learning <i>Patsornchai Noppakun; Khajonpong Akkarajitsakul</i>	15
1570822758	Web-Based System for Post Covid-19 Telerehabilitation Research <i>Krisda Lengwehasatit; Theerapat Meetham; Itthi Suwanosth; Patipan Lueangoon; Srisupang Thewsuwan</i>	19
1570824071	Detecting Security Violations on IoT Devices in Home Automation Systems Using a Lightweight Security Handshake Protocol <i>Pipat Sookavatana</i>	23
1570824721	Guava Bruise Area Calculation Using Color and Grayscale Image Segmentation <i>Patteera Vipasdamrongkul; Suttika Chocharat; Pundao Srimunwing; Sujitra Arwatchananukul; Saowapa Chaiwong; Rattapon Saengrayap; Nattapol Aunsri</i>	29

ID	TITLE	PAGE
1570825500	Meme Scraper: A Web Application for Internet Meme Spread Pattern Analysis <i>Songsri Tangsripairoj; Pasathorn Luengpattana; Teerapat Sriboonsong; Thanapat Piyakulpinyo</i>	35
1570825805	The Pedagogy Gamification Design for Fun Engagement <i>Wilawan Inchamnan</i>	39
1570826043	Beauty Face: An Android Application for Cosmetic Consumers to Try on and Receive Product Recommendation <i>Songsri Tangsripairoj; Sarun Junbang; Thananya Chattranusorn; Patchara Chinmanopan</i>	45
1570826676	Optimization of Deep Neural Network Models Based on JTRT Technique <i>Zihao Nie; Jian Qu</i>	49
1570829885	Effectiveness of BERT Model with the Weaker Loss Function for Chinese Keyword Extraction on Crowdfunding Projects <i>Qi Li; Jian Qu</i>	55
1570830431	A Prediction Model for Screening Covid-19 Patients <i>Siwakorn Banluesapy; Waraporn Jirapanthong</i>	59
1570830441	Research on Self-Driving Based on Dynamic Recognition of Traffic Signs <i>Shukai Ding; Jian Qu</i>	64
1570830764	Optimization of Lightweight Deep Neural Network Models for Steering Angle Prediction <i>Youwei Li; Jian Qu</i>	69
1570831874	The SWC-Based Security Analysis Tool for Smart Contract Vulnerability Detection <i>Nattawat Songsom; Warodom Werapun; Jakapan Suaboot; Norrathep Rattanavipanon</i>	74

ID	TITLE	PAGE
1570833366	Development of Low Cost 3 Phases IoT Electrical Power Meter <i>Anusorn Yodjaiphet; Ronnachai Sretawat Na Ayutaya; Suppakarn Chansareewittaya</i>	78
1570833382	The Required Analysis for Quality Household Disaster Data for the National Disaster Management Agency, the GAMBIA <i>Amadou Sanneh; Damrongpol Kamhangwong; Santichai Wicha</i>	83
1570833679	Web Based Keyword Extraction on Crowdfunding Projects with Novel Features <i>Wenting Hou; Jian Qu</i>	87
1570834778	Design of an Edge Detected CMOS Image Sensor for an Intelligent Pattern Recognition <i>Hohyun Lee; Minkyu Song</i>	92
1570835140	Automated COVID-19 Screening Framework via Deep Convolutional Neural Network With Chest X-Ray Medical Images <i>Waris Damkham; Tipajin Thaipisutikul; Akara Supratak; Jidapa Kraisanaka; Pattanasak Mongkolwat; Jia-Ching Wang</i>	96
1570835232	Thai Sentiment Analysis and Visualization of Movie Reviews From Social Media <i>Peerumporn Jiranantanagorn; Thararat Puangsuwan</i>	100
1570835342	Fingerprint Liveness Detection With Voting Ensemble Classifier <i>Napahatai Sittirit; Akara Supratak; Tipajin Thaipisutikul; Pattanasak Mongkolwat; Zhi-Sheng Chen; Jia Ching Wang</i>	105
1570835385	Adaptive Noise Cancellation Using a Fully Connected Network: A Lesson Learned <i>Phakamin Tantiwatanavorakul; Joranin Duangchan; Dahmmaet Bunnjaweht</i>	111

ID	TITLE	PAGE
1570835492	Risk Analysis of Encountering Dark Patterns of Ux e-Commerce Applications Affecting Personal Data <i>Apichaya Nimkoompai</i>	115
1570835493	Data Clustering Using Particle Swarm Optimization for Pairwise Microarray Bioinformatics Data <i>Pacharaon Sanprasert</i>	120
1570835527	Solving Single-Vehicle Open-Loop VRPPD With a Limit of Distance Constraint by Using the Genetic Algorithm <i>Peerayu Phengsuwan; Teerapol Silawan</i>	125
1570835530	Hyperlocal Optimal Solid Waste Generation Prediction Model Case Study: Saensuk Municipality, Chon Buri <i>Kittiya Thibuy; Prajaks Jitngernmadan</i>	129
1570835543	Field Test Evaluation of an AI Model for Recycle Waste Separation Running on Embedded Systems <i>Sorawit Thokrairak; Prajaks Jitngernmadan</i>	134
1570835557	Microgrid Loads Clustering in an Electricity Feeder Using Genetic Algorithm With Applied DBSCAN Techniques <i>Jarupoj Tanomrug; Chaiyachet Saivichit; Teerapol Silawan</i>	139
1570835562	Method Evaluation of Usability for Small Size Software <i>Natsuda Kasisopha; Sirisuda Thiangfak; Boonchai Charoendouysil; Thanapol Wisuttikul; Panita Meananeatra</i>	143
1570835577	Emotion Classification in Thai Music Using Convolutional Neural Networks <i>Sitdhibong Laokok; Subhorn Khonthapagdee</i>	148
1570835641	Machine Learning Techniques to Detect Failure in Hard Disk Drive Test Process <i>Arunee Sridee; Prabhas Chongstitvatana</i>	152

ID	TITLE	PAGE
1570835724	System Design of a Toxic Waste Management: Empirical Study for Chiang Rai Province <i>Kemachart Kemavuthanon; Panate Manomaivibool; Anant Eungwanichayapant</i>	157
1570835752	Need Analysis of a Rewarding System Based on Design Thinking in Respect of Waste Sorting Behavior, Case Study: Saensook City <i>Benchaporn Jantarakongkul; Prawit Boonmee; Kanuengnij Kubola; Thatsanee Charoenporn; Prajaks Jitngernmadan</i>	162
1570835863	Qurban Animal Application Innovation Using Design Thinking Method: In Facing Eid Al-Adha in Indonesia <i>Emiya Fefayosa Br Tarigan; Rahmat Yasirandi; Fahdah Almarshad; Isa Mulia Insan; Novian Anggis Suwastika</i>	167
1570835921	Improving ID3 Algorithm by Filtering Out Attributes With Values 0 or 1 <i>Pinyarat Chuenprasertsuk; Kietikul Jearanaitanakij</i>	173
1570836024	Behavioral Office Syndrome with IoT Devices <i>Pun Kongsoomboon; Surapong Uttama</i>	177
1570836075	Gamification of Donation App: What Affect Donators' Decision? <i>Peetikorn Preechachot; Thidawan Chaichana; Surapong Uttama</i>	182
1570836548	Improving the Face Recognition Performance Using Gabor and VGGFace2 Features Concatenation <i>Essam Al Daoud; Ghassan Samara</i>	187
1570837190	Analyzing of Crowdfunding Projects Using BERT Sentence Summarization <i>Woottikarn Hongwiengchan; Pisit Charnkeitkong; Jian Qu</i>	191
1570837340	A Fast System for Person Description Search in Videos <i>Sumeth Yuenyong</i>	196

ID	TITLE	PAGE
1570837890	The Effect of Data Anonymization on a Data Science Project <i>Kulkatechol Kanokngamwitroj</i>	201
1570839344	Finetuning Language Model for Person Description Search in Thai <i>Sumeth Yuenyong</i>	207
1570840911	Guideline for Data Anonymization for Data Privacy in Thailand <i>Jiraphat Lapwattanaworakul</i>	211
1570840929	HELPNAYAN: An Adaptive Learning System Utilizing Bayesian Network and Felder-Silverman Learning Style Model to Improve Grade 10 Students' Learning in Physics <i>Orland D Tubola; Jay S Yamongan; Richard P. Alcantara; Jon Bernard P Barracas; Joshua Miguel N. Manao; Geoffrey T Salvador</i>	216
1570840931	YOLO KeepSafe: Utilization of YOLOv4-Based Algorithm to Employ a Real-Time People Detection and Social Distance Monitoring System <i>Orland D Tubola; Renz Leonard E. Espino; Ronnel DS Capili; Allen Aldrie T. Comsti; Arjay D. Ordinario</i>	222
1570841097	AidGebra: An Adaptive Learning Environment Built With Fuzzy Logic and Decision Tree for Filipino Grade 7 Algebra Students <i>Orland D Tubola; Lyra Joy Marquez Formes; Hyde Talosig Arellano; Gem A. Galicinao; Giselle A. Peña; Geoffrey T Salvador; Ana Liza R. Publico</i>	228
1570842902	Outlier Detection Using Ensemble Learning <i>Moirangthem Marjit Singh; Nongmaithem Kane</i>	234
1570843075	Disambiguation of Web Search Terms Based on Clustering Using Page Rank and Distance Between Words <i>Yukinobu Miyamoto</i>	240

ID	TITLE	PAGE
1570843100	Investigating the Determinants of Cloud Storage Services Adoption in Higher Education <i>Warut Ploysuayngam; Sakchai Tangwannawit</i>	245
1570843309	Video Analysis and Deep Learning for Contact Rate Estimation in Public Places and Mass Gatherings in Saudi Arabia <i>Sultanah M Alshammari; Asma Mohammed Alghamdi; Suha Rushdi Bako; Zahrah Ahmad Al Safwan</i>	251
1570843390	Building A Barrier: A Security Operations Center Framework for A Sustainable Smart Campus Network <i>Anazel Gamilla; Thelma Palaoag</i>	256
1570843575	A Deep Learning Approach for Prediction of Respiratory Disease From Air Quality <i>Sathien Hunta; Rattasak Pengchata</i>	262
1570844613	Classification of News Articles Using Gradient Boosting Based Deep Learning Model <i>Pradeep Kamboj; Lisu Chongtham</i>	266
1570844710	Design Educational VR Application Through TPACK Model: A Case Study of Basic Scientific Experiment for Secondary School Students in Thailand <i>Yoothapong Tongpaeng; Phonghiphat Kewirat</i>	270
1570844721	Designing Augmented Learning Platform With IoT and Chatbot-Based Learning Technology for Primary School Students in Northern Thailand <i>Pruet Putjorn</i>	275
1570844864	Semi-Automatic Short Answer Clustering and Grading With K-Means and Keyword Matching Algorithms <i>Chatchai Wangwiwattana; Yuwaree Tongvivat</i>	280

ID	TITLE	PAGE
1570844878	Android-Based Real-Time Road Accident Reporting Application <i>Carlos A. Villanueva</i>	285
1570844954	Predicting On-The-Job Training Performance of IT Students on Virtual Internship Using Naïve Bayes <i>Anjela C Tolentino; Thelma Palaoag</i>	289
1570844962	Voice Recognition and Text-To-Speech Implementation on Virtual Assistant for Individuals with Borderline Personality Disorder <i>Ridwan Sanjaya; Wibhowo Christin</i>	293
1570844973	A Framework to Develop the Tools and Methods for Supporting Self-Regulated Learning and Programming Strategies <i>Apichaya Khwankaew; Chareefah Hutye</i>	298
1570845014	Expectation-Confirmation Model (ECM) to See Satisfaction and Continued Intention of e-Learning ("Cyber") <i>FX Hendra Prasetya; Albertus Dwiyoga Widianoro; Bernardinus Harnadi; Andre Kurniawan Pamudji</i>	303
1570845032	Shape Recognition Using Unconstrained Pill Images Based on Deep Convolution Network <i>Ureerat Suksawatchon; Supawadee Srikamdee; Jakkarin Suksawatchon; Worawit Werapan</i>	309
1570845068	External Validation of Deep Learning Algorithm for Tuberculosis Detection in Thai Population <i>Amir Rajak; Warasinee Chaisangmongkon</i>	314
1570845157	Development of Mobile Application for Supporting Community-Based Tourism <i>Rathavann Phally; Apisit Thanvises; Suphakit Kiatkanok</i>	320

ID	TITLE	PAGE
1570845219	Review of User Comments for the OVO Fintech Application Using LDA <i>Albertus Dwiyoga Widiantoro; Bernardinus Harnadi</i>	326
1570845333	Thai License Plate Recognition Based on YOLO Detector and CNN-Classifer <i>Phongsak Keeratiwintakorn; Ronnakorn Rattanakornphan; Thepparit Ruttanapunyagorn</i>	331
1570845417	Blowing the Truth: Strengths and Weaknesses in Creating Whistleblowing System for Higher Education Institutions <i>Theresia Dwi Hastuti, Mrs; Ridwan Sanjaya; Benedictus Danang Setianto</i>	337
1570845580	IoT Based Aquarium Water Quality Monitoring and Predictive Analytics Using Parameter Optimized Stack LSTM <i>Ferdin Joe John Joseph</i>	342
1570845587	Utilization of Augmented Reality-Based Application to Promote Digital Citizenship <i>Andre Kurniawan Pamudji; Cecilia Murniati; Heny Hartono; Angelika Riyandari; Rikarda Ratih Saptaastuti</i>	347
1570845658	Understanding Behavioral Intention to Use Social Media Technology: Two Comparing Model, TAM and UTAUT <i>Bernardinus Harnadi; FX Hendra Prasetya; Albertus Dwiyoga Widiantoro</i>	352
1570845850	Particle Filtering with Adaptive Diversifying Scheme for Abruptly Changing Hidden States Estimation <i>Chanin Kuptamettee; Nattapol Aunsri</i>	358
1570845874	Sequential Frequency Estimation Using Auxiliary Particle Filter <i>Chanin Kuptamettee; Nattapol Aunsri</i>	363

ID	TITLE	PAGE
1570845922	Lessons Learned From Penetration Testing Hands-On Training During COVID-19 Pandemic <i>Songpon Teerakanok; Ittipon Rassameeroj; Assadarat Khurat; Vasaka Visoottiviseth</i>	368
1570845949	A VR System for Earthquake Evacuation Drills with Scoring Feedback Based on Learner Behavior and Actions <i>Kaho Yamamoto; Mitsunori Makino</i>	374
1570846052	The Integration of Multiple Recognition Technologies and Artificial Intelligence to Facilitate EFL Writing in Authentic Contexts <i>Wu-Yuin Hwang; Rio Nurtantyana</i>	379
1570846110	A Self-Augmentation Transfer Learning Network for Image Deraining <i>Patsakorn Akephachaisawat; Sapon Phumeechanya</i>	384
1570846151	A Case Study of Academic Activity Announcement System Prototyping as a Usability Assessment Technique <i>Thanaphat Saefung; Khanittha Srisukwarophas; Chengwei Tan; Prasara Jakkaew; Sujitra Arwatchananukul</i>	390
1570846169	Investigating Abnormal Transaction Detection of Manual Toll Collection (MTC) of Expressway <i>Boonsit Sujitwanich; Krishna Chimmanee</i>	394
1570846202	A Study of Comparative Methods for Closed-Price Cryptocurrency Prediction <i>Jantima Polpinij; Chanapon Phasook; Bancha Luaphol</i>	399
1570846217	The Classification of Edible-Nest Swiftlets Using Deep Learning <i>Amy Sungsiri; Sarayut Nonsiri; Annop Monsakul</i>	404
1570846224	Digital Forensic Analysis of Ransomware Attacks on Virtual Private Network: A Case Study in Factories <i>Nattawut Khantamonthon; Krishna Chimmanee</i>	410

ID	TITLE	PAGE
1570846255	Digital Forensic Analysis of Ransomware Attacks on Industrial Control Systems: A Case Study in Factories <i>Phitaya Nakhonthai; Krishna Chimmanee</i>	416
1570846273	The Finding of Factors to Motivate Stakeholders in the Coffee Supply Chain Towards the Use of Blockchain Technology: Case of Chiang Rai Coffee Supply Chain <i>Phusanee Surarityothin; Damrongpol Kamhangwong; Puwanart Fuggate; Santichai Wicha</i>	422
1570846510	Towards Employee-Driven Idea Mining: Concept, Benefits, and Challenges <i>Stephan Leible; Max Ludzay</i>	428
1570847731	Linguistic Resources Construction for Food and Beverages in Thai Texts for Product Storytelling Text Generation <i>Piyawat Inmurak; Nattapong Tongtep</i>	434
1570848059	In-Memory Synchronization Platform for Electronic Toll Collection via Computer Network of the Expressway in Thailand <i>Jaroonsak Chaiprasitjinda; Krishna Chimmanee</i>	440
1570849084	ResNet-Based Deep Neural Network Using Transfer Learning for Animal Activity Recognition <i>Sakorn Mekruksavanich</i>	445
1570849406	Pre-Impact Fall Detection Based on Wearable Inertial Sensors Using Hybrid Deep Residual Neural Network <i>Sakorn Mekruksavanich</i>	450
1570852069	Accuracy Improvement of Complex Sensor-Based Activity Recognition Using Hybrid CNN <i>Sakorn Mekruksavanich</i>	454
1570852119	Effectiveness of the Injection Points <i>Yuwanuch Gulatee; Arunrat Utaisang; Yuwadee Yoosabai; Watipa Unarat; Khunphitha Junsevg; Sathapon Wongsiri</i>	458

ID	TITLE	PAGE
1570852129	<p>An Innovate Noise Extinguish Technique Ground on Iterative Median Filter for Low-Density Fix-Valued Impulse Noise</p> <p><i>Vorapoj Patanavijit; Darun Kesrarat; Kitipoth Wasayangkool; Wilaiporn Lee; Kornkamol Thakulsukanant</i></p>	463
1570852148	<p>The MDBUTMF Aberration Exposure Routine for Aberration Extirpating on Constant Sizableness Impulsive Noise (CSIN)</p> <p><i>Vorapoj Patanavijit; Kitipoth Wasayangkool; Wilaiporn Lee; Kornkamol Thakulsukanant</i></p>	467
1570852154	<p>Analysis of Modern Image Classification Platforms for Bone Fracture Detection</p> <p><i>Adisorn Kheaksong; Pongsakorn Samothai; Parinya Sanguansat; Kanabadee Srisomboon; Wilaiporn Lee</i></p>	471
1570852380	<p>Evaluation of Masked Face Recognition of FaceNet Implemented With Machine Learning Algorithms</p> <p><i>Adisorn Kheaksong; Thanathip Ngamloed; Pongsakorn Samothai; Parinya Sanguansat; Kanabadee Srisomboon; Wilaiporn Lee</i></p>	475
1570852795	<p>An Online Gap Analysis on Cyber Security Principles for Thailand Organizations Based on ISO/IEC 27001:2013 Standard</p> <p><i>Narong Chaiwut; Worasak Rueangsirarak</i></p>	479

ORGANIZERS

- Association of Council of IT Deans in Thailand
- IEEE Thailand Section
- IEEE Computer Society Thailand Chapter
- ECTI Association
- AIAT Association
- Faculty of Information Science and Technology,
Mahanakorn University of Technology, Thailand
- School of Information Technology,
King Mongkut's University of Technology Thonburi, Thailand
- College of Innovative Technology and Engineering,
Dhurakij Pundit University, Thailand
- Faculty of Information Technology and Digital Innovation,
King Mongkut's University of Technology North Bangkok, Thailand
- Faculty of Information Technology,
King Mongkut's Institute of Technology Ladkrabang, Thailand
- Faculty of Information and Communication Technology,
Mahidol University, Salaya Campus, Thailand
- School of Information Technology, Mae Fah Luang University, Thailand
- College of Computing, Prince of Songkla University Phuket Campus, Thailand
- School of Information Technology and Innovation, Bangkok University, Thailand
- School of Information Technology, Sripatum University, Thailand
- College of Digital Innovation and Information Technology,
Rangsit University, Thailand
- Faculty of Informatics, Mahasarakham University, Thailand
- School of Informatics, Walailak University, Thailand
- Faculty of Information Technology, Siam University, Thailand
- Faculty of Management Sciences and Information Technology,
Nakhon Phanom University, Thailand
- Faculty of Information and Communication Technology,
Silpakorn University, Petchburi IT Campus, Thailand
- Faculty of Information Technology, Thai-Nichi Institute of Technology, Thailand
- Faculty of Engineering and Technology,
Panyapiwat Institute of Management, Thailand
- Faculty of Informatics, Burapha University, Thailand

- School of Information and Communication Technology,
University of PhaYao, Thailand
- Faculty of Computer Science Ubon Ratchathani Rajabhat University, Thailand

TECHNICAL SPONSORS



IEEE Thailand Section



IEEE Computer Society Thailand Chapter



**The Electrical Engineering/Electronics, Computer, Telecommunications and
Information Association (ECTI) Thailand**



Artificial Intelligence Association of Thailand (AIAT)

HOSTS



The Association of Council of IT Deans (CITT)



Arduino, Raspberry Pi, and Smartphone Usage Comparison for Voice-based Virtual Assistant

Ridwan Sanjaya
Information System Department
Soegijapranata Catholic University
Semarang, Indonesia
ridwan@unika.ac.id

Christin Wibhowo
Psychology Department
Soegijapranata Catholic University
Semarang, Indonesia
christine@unika.ac.id

Abstract—A virtual assistant or an artificial intelligence chatbot is one of the technological interventions to help individuals with borderline personality disorder (BPD). The virtual assistant must have a bank of knowledge to answer the questions from individuals with BPD to accompany and chat with them like a digital friend. As part of artificial intelligence software, Program-O can handle the interaction between users and the bank of knowledge in the server. The voice recognition and text-to-speech features can be used to enhance the virtual assistant's function to become even closer as a friend. There are three possibilities for implementing voice recognition and text-to-speech features on virtual assistants, which are using Arduino, Raspberry Pi, and smartphone devices. All these three devices can be connected to the speech recognition module or Application Protocol Interface (API) for voice recognition on the internet. This paper will explore and compare several aspects of the implementation of voice recognition and text-to-speech features in the virtual assistant. The result will be a recommendation for the application of voice recognition and text-to-speech features on a virtual assistant for individuals with BPD.

Keywords- *borderline personality disorder; chatbot; digital friend; text to speech; virtual assistant, voice recognition*

I. INTRODUCTION

Individuals with borderline personality disorder (BPD) have a high risk of suicide. In previous studies [1], 9-33% of suicides were committed by individuals with BPD. There is no single most effective and sustainable approach to prevent them from committing suicide [2]. However, accompanying them will create opportunities to make them more stable, less hopeless, and less alone.

Creating a digital friend such as a virtual assistant with artificial intelligence and the ability to respond to them when they need someone to talk to is one approach that has been tried in previous research [3]. The advantage of the virtual assistant is that they can accompany them within 24 hours when BPD symptoms appear. In addition, their confidentiality is also better maintained because the virtual assistant does not inform other people about their conversation.

Technically, a voice-based virtual assistant shown consists of a program with a bank of knowledge that can answer based on question patterns, a voice recognizer, and text-to-voice. In previous studies, mobile applications whose gadgets are equipped with

voice recognition and text-to-speech features that are connected to a computer server equipped with a knowledge database have been able to answer these needs. The bank of knowledge can be improved according to the needs and development of the case.

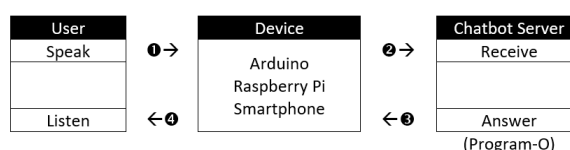


Figure 1. Communication flow in voice-based chatbot

Portable devices like Google Nest and Amazon Alexa should be the solution to answer their needs more interactively. Google Nest and Amazon Alexa are examples of smart speakers that come with Google Assistant. Some activities, such as playing music, turning on the television, asking about the weather, or planning activities, can be done using the user's voice.

However, the device is limited to some functions and cannot connect to the chatbot. To realize a virtual assistant in the form of a portable device, Arduino and Raspberry Pi were explored to be used and connected to a server with a knowledge database. These devices can connect to the server and have the ability to recognize voice using an additional module, a minimum requirement for the voice function on the virtual assistant.

Arduino is an open-source electronic circuit board whose main component is a microcontroller chip with additional components that can be customized according to specific needs. Arduino can be added with a Wi-Fi module to have functionality on an internet connection. The circuit board can be added with a speech recognition module to understand the user's voice. Each addition of modules and functions will increase the power needed by Arduino to work.

The Raspberry Pi is a single-board pocket-sized minicomputer that is equipped with an operating system and can be used to run computer applications. It has Bluetooth, Wi-Fi, and ethernet built-in devices. Like the Arduino board, the Raspberry Pi board can be connected to additional modules to gain access to input/output devices used by desktop computers.

Several aspects, such as the total cost of providing device components, ease of assembling the device, and device functionality of these two devices, will be compared with a smartphone to determine which

devices are recommended to serve the function as virtual assistants for individuals with BPD. The results can also determine the possibility of the device being developed in other forms, such as smart speakers or other smart devices.

II. CHATBOT KNOWLEDGE MANAGEMENT

Program-O is an open-source web-based application used for knowledge management needed by chatbots in responding to individuals with BPD [3]. The source of the application can be downloaded via the URL <https://github.com/Program-O/Program-O>. It is used to manage knowledge in Artificial Intelligence Markup Language (AIML) format in terms of adding, changing, deleting, displaying, searching, training, and compiling knowledge formats in AIML.

AIML as a source of knowledge for chatbots must be created using unique question patterns from each other, previous conversation references, or conversation topic groupings. When the patterns of questions are arranged to overlap each other, the resulting responses can be confusing and different from the expectations. For the response to meet expectations, it is necessary to take full advantage of the various tags used in AIML, especially in terms of separating question topics and associating the responses to the context of the previous conversation.

To give different responses to each topic's conversation, AIML has the <topic> tag. Even though the questions are the same, the answers will differ based on the topic set in the previous conversation using the <set> tag. The example of using the <topic> tag in AIML can be seen in Figure 2. When the users talk about movies, the following responses about the marvel and comedy keywords will be different when the users talk about music. The conversation about the pop keyword can be responded to only when the users talk about music.

```
<aiml>
<category>
  <pattern>* MOVIES</pattern>
  <template>Let's talk about <set name="topic">movies</set></template>
</category>
<category>
  <pattern>* MUSIC</pattern>
  <template>Talk about <set name="topic">music</set></template>
</category>
<topic name="music">
  <category>
    <pattern>* POP</pattern>
    <template>I do not like pop music</template>
  </category>
  <category>
    <pattern>* MARVEL</pattern>
    <template>I do not have any marvel music soundtrack.</template>
  </category>
  <category>
    <pattern>* COMEDY</pattern>
    <template>Comedy music? I prefer podcast.</template>
  </category>
</topic>
<topic name="movies">
  <category>
    <pattern>* MARVEL</pattern>
    <template>Watching Marvel movie stimulates our minds.</template>
  </category>
  <category>
    <pattern>* COMEDY</pattern>
    <template>I like comedy movies too.</template>
  </category>
</topic>
</aiml>
```

Figure 2. Using tag <topic> to separate topics.

To continue the previous conversation, AIML provides <that> tag to associate the answers with the previous chatbot's responses. Even though the

questions are the same, the answers will differ based on the previous chatbot's responses mentioned in <that> tag, as seen in Figure 3.

```
<category>
  <pattern>* HOBBIES</pattern>
  <template>What hobbies do you like?</template>
</category>
<category>
  <pattern>* BASKET</pattern>
  <that>What hobbies do you like</that>
  <template>Do you know Michael Jordan?</template>
</category>
<category>
  <pattern>YES</pattern>
  <that>Do you know Michael Jordan</that>
  <template>How I know your age?</template>
</category>
<category>
  <pattern>NO</pattern>
  <that>Do you know Michael Jordan</that>
  <template>I understand</template>
</category>
```

Figure 3. Using tag <that> to associate with the previous conversation.

AIML also has the <condition> tag to set the chatbot's response based on the first conversation. Consistent responses will keep users talking in the context of the previous conversation and not having to speak in complete sentences. The example of using the <condition> tag can be seen in Figure 4. When users talk about Bangkok, the following answer is all about Bangkok. The same condition can also be seen when the user talks about the city of Manila and the city of Semarang. The responses will all be related to that city.

```
<category>
  <pattern>* KNOW *</pattern>
  <template>
    <think><set name="quest"><star index="2"/></set></think>
    <condition name="quest">
      <li value="Bangkok">Bangkok is a City of Angels</li>
      <li value="Manila">Manila is a Pearl of Orient</li>
      <li value="Semarang">Semarang is the Venice of Java</li>
      <li>Huum I do not know</li>
    </condition>
  </template>
</category>
<category>
  <pattern>WHERE *</pattern>
  <template>
    <condition name="quest">
      <li value="Bangkok">Bangkok is in Thailand</li>
      <li value="Manila">Manila is in the Philippines</li>
      <li value="Semarang">Semarang is in Indonesia</li>
      <li>I am so sorry</li>
    </condition>
  </template>
</category>
```

Figure 4. Using tag <condition> to follow the conversation.

The chatbot knowledge management should be done to make the individuals with BPD feel comfortable and not feel annoyed by having to repeat questions or because of responses that are not contextually appropriate. The work result of chatbot knowledge management is expected to increase the capability of responding to users. The chatbot responses can be processed in other forms according to the expected target.

Other applications can read the responses from Program-O by setting the output as JSON or XML format. The output will be used to relate the question from the user with the answer stored in the O-Program using any programming language. An example of an application that uses JSON output from Program-O is a LINE-based Virtual Friend named Sovi Lau, which stands for "Sobat Virtual Anti Galau" or "Anti-Stress Virtual Friend" [4]. LINE Messaging API will communicate with the chatbot server by sending the user's message, receiving the JSON-based response,

and displaying responses in sentences humans can understand.

Chatbot responses can be engineered into voice to give users new experiences like talking to friends and might be needed by individuals with BPD.

III. VOICE-BASED CHATBOT DEVELOPMENT

In implementing a voice-based chatbot on all three devices as virtual friends for individuals with BPD as shown in Figure 5, several additional components are needed to perform the following functions: listening to the user's voice, converting voice to text, sending a text to the chatbot server, receiving text responses from the server chatbots, and converting text to voice.

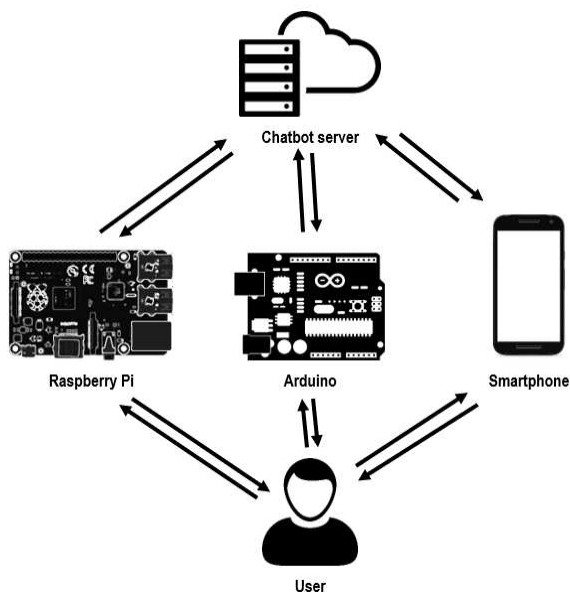


Figure 5. Voice-based chatbot Scenario

A. Arduino

The use of Arduino devices requires additional modules for voice recognition and the internet of things (IoT) [5] as shown in Figure 6. The voice recognition module is used to mediate the user's voice recognition and process it in the microcontroller. While the IoT module is used to send commands from the microcontroller to the chatbot server and receive responses from the chatbot server. The ESPduino-32 board can be used to facilitate the provision of an Arduino that has been equipped with an ESP-32 module for Wi-Fi connection [6]. Voice Recognition Module v3.1 can detect and change voices in certain activities [7]. Approximately all those devices will cost around 30-40 USD.

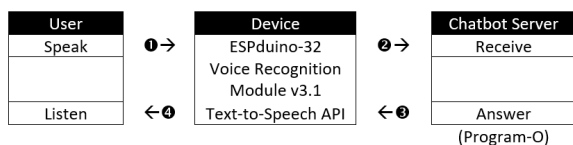


Figure 6. Arduino in voice-based chatbot

B. Raspberry Pi

Raspberry Pi, as a minicomputer [8], has complete functions to process every task, including the Wi-Fi function for transferring the text or any requests to the chatbot server. The board only needs a GPIO expansion board, a ReSpeaker 4-Mic Array module, and a USB microphone as additional devices as shown in Figure 7. The ReSpeaker 4-Mic Array module functions to recognize the user's voice [9], the USB microphone functions as the user's voice input, and the GPIO expansion board functions to mediate the connection between the Raspberry Pi board and ReSpeaker 4-Mic Array module. Approximately all those devices will cost around 200-210 USD.

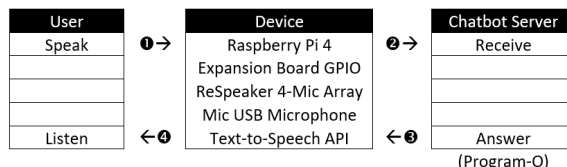


Figure 7. Raspberry Pi in voice-based chatbot

C. Smartphone

Current smartphones can recognize the voice and facilitate text-to-speech. It only requires the mobile application to receive the user's voice, convert the voice to text, send the text to the chatbot server, wait for the text response from the chatbot server, and convert the text to voice, as seen in Figure 8. The application developers can only use MIT App Inventor to provide these functions within the application [10]. This tool has limited skill requirements to operate website-based applications to create Android-based mobile applications [11]. The minimum specifications of a smartphone with the required capabilities will cost around 30-35 USD, depending on the smartphone's brand.

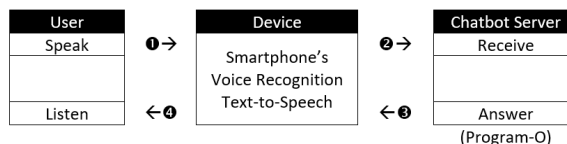


Figure 8. Smartphone in voice-based chatbot

IV. EVALUATION OF DEVICES

Several factors must be considered when deciding which voice-based chatbot device to develop. These factors are cost, difficulty, and functionality. The cost factor is the money spent to develop the device's intended function. The difficulty factor is the effort of providing hardware, technical aspects, and developing the supporting application. The functional factor is the function of understanding the voice, connecting with the chatbot server, and displaying the chatbot response.

A. Device Cost

In assembling the supporting components of a voice-based chatbot using Arduino as the main device, the cost is around 30-40 USD. Assembling a

Raspberry Pi with a voice-based chatbot support devices costs around 200-210 USD. The cheapest smartphone purchases cost around 30-35 USD or more depending on the smartphone brand. The most expensive expense is in assembling the Raspberry Pi. The other two options cost in the same range. The cost comparison of the three devices can be seen in table I.

TABLE I. COST RANK

Device	Cost	Rank
Arduino	30-40 USD	2
Raspberry Pi	200-210 USD	1
Smartphone	30-35 USD	2

B. Device Assembly Difficulty

Raspberry Pi as a minicomputer has the minimum specifications required for office work, but for multimedia purposes, additional components are needed. In terms of providing additional components, the provision of a ReSpeaker 4-mic Array module connected to the Raspberry Pi via the GPIO Expansion Board and voice input using a USB Microphone Mic connected to the Raspberry Pi has the same difficulty as adding components on the Arduino board circuit with ESP32 components to Wi-Fi and Voice Module v3.1 components for voice recognition. However, the use of ESPduino-32 which is a combination of Arduino board and ESP-32 module makes it a little easier and reduces the number of components that need to be provided. The current smartphones have all the functions needed so additional devices to work as planned is not needed. The order of providing the most difficult hardware is Raspberry Pi, Arduino, and smartphone.

After providing the hardware, it is needed to assemble all the components with the main board. Even though Raspberry Pi and Arduino almost have similar effort to assemble, Raspberry Pi has more components to manage than Arduino. smartphones are ready to be used. Users can use all functions needed without any technical intervention. The order of the most difficult technical aspects is Raspberry Pi, Arduino, and smartphone.

A similar situation also occurs when installing programs to make the three devices function as planned. Installing some programs and training the hardware are needed to understand the users' voice. Almost the same as the other two aspects, Raspberry Pi and Arduino almost have the same difficulty, but the Raspberry Pi has more programs to be installed than in the Arduino because Raspberry Pi has an operating system, but Arduino does not. However, each hardware has to be connected to an API to have the needed voice function. The smartphone has operating system features and can work as targeted without any additional APIs. Users only use the existing features through easy procedures. The order of the most difficult application development is Raspberry Pi, Arduino, and smartphone. The comparison of difficulty levels in hardware provision,

technical aspects, and application development discussed above can be seen in table II.

TABLE II. LEVEL OF DIFFICULTY

Device	Level of Difficulty		
	Hardware Provision	Technical Aspects	Application Development
Arduino	2	2	2
Raspberry Pi	1	1	1
Smartphone	3	3	3

C. Device Functionality

Those three tools can achieve the most targeted functions but at different levels of implementation. For example, Arduino can recognize voice only in the form of a word but not in a sentence. Each recognized word will trigger an action on the Arduino. However, Raspberry Pi and Smartphone can recognize the voice in the form of a word or a sentence.

Arduino can perform its functions on the chatbot server connection through the ESP32 module that functions as Wi-Fi. While on the Raspberry Pi, this feature is embedded in the minimum Raspberry Pi package. The same thing is found on smartphones with Wi-Fi by default features. It can be said all three can perform the function of connecting to the chatbot server.

However, compared to the two device's functional experiments above, different results are obtained in getting responses from the chatbot server. Arduino is failed to provide chatbot responses because the voice recognition function through Voice Recognition Module v3.1 is limited to a keyword. The complete words cannot be recognized and an appropriate response cannot be given. Arduino cannot give the expected response because it can only detect one word for each action. The expected answer from responding to complete sentences cannot be achieved. Both Raspberry and smartphones can recognize long sentences and can provide responses from appropriate chatbots. The ReSpeaker 4-Mic Array module connected to the Raspberry Pi enables speech recognition and functions within Amazon Alexa and Google Home. While the voice features that have been embedded in the smartphone make it a facility from the start. The comparison of functionality in voice recognition, connection to chatbot server, and chatbot responses for the three devices discussed above can be seen in table III.

TABLE III. DEVICE'S FUNCTIONALITY

Device	Functionality		
	Voice recognition	Connection to chatbot server	Chatbot responses
Arduino	V	V	X
Raspberry Pi	V	V	V
Smartphone	V	V	V

V. CONCLUSIONS

The devices used to integrate voice recognition features with AIML-based chatbots that function as needed are smartphones and Raspberry Pi. But in terms of cost, a smartphone with low specifications for 30-35 USD can be used for these needs. While the cost of Raspberry Pi reaches 200-210 USD. In terms of difficulty level, Raspberry Pi has a greater level of difficulty than a smartphone.

The integration of voice recognition features with an AIML-based chatbot can be done by utilizing the speech recognition and text-to-speech features in smartphones and available features in making applications using MIT App Inventor. Speech recognition translates the user's voice into text and sends it to the chatbot server. Then, the chatbot server will receive the sent sentence and answer based on its word pattern. By a smartphone, the answer will be converted into voice through the text-to-speech feature and played for the user.

Overall, based on the benchmarking of the three devices, the use of smartphones is recommended in presenting voice recognition features in chatbots as it is faster, cheaper, and easier. Making a smartphone application using MIT App Inventor can already activate the voice recognition and text-to-speech functions needed for a voice-based chatbot.

ACKNOWLEDGMENT

This research was funded by the Indonesian Ministry of Research and Higher Education under the scheme of Higher Education Fundamental Research Excellence Grant in 2022 titled Borderline Personality Disorder Assistance Model using Virtual Assistant Technology.

REFERENCES

- [1] M. Pompili, P. Girardi, A. Ruberto, and R. Tatarelli, "Suicide in borderline personality disorder: a meta-analysis," *Nord. J. Psychiatry*, vol. 59, no. 5, pp. 319–324, 2005.
- [2] J. Paris, "Suicidality in Borderline Personality Disorder," *Medicina (B. Aires)*, vol. 55, no. 6, p. 223, 2019.
- [3] C. Wibhowo and S. Ridwan, "Virtual Assistant to Suicide Prevention in Individuals with Borderline Personality Disorder," in *International Conference on Computer and Information Science*, 2020.
- [4] L. V. Oey, R. Sanjaya, and C. Wibhowo, "LINE-based Virtual Friend Development for Borderline Personality Disorder," in *2021 International Conference on Computer Science, Information Technology, and Electrical Engineering (ICOMITEE)*, 2021, pp. 80–85.
- [5] M. Schwartz, *Internet of Things with Arduino Cookbook*. Birmingham, UK: Packt Publishing Ltd, 2016.
- [6] A. Hidayat *et al.*, "Designing IoT-Based Independent Pulse Oximetry Kit as an Early Detection Tool for Covid-19 Symptoms," in *2020 3rd International Conference on Computer and Informatics Engineering (IC2IE)*, 2020, pp. 443–448.
- [7] K. Khotimah *et al.*, "Validation of Voice Recognition in Various Google Voice Languages using Voice Recognition Module V3 Based on Microcontroller," in *2020 Third International Conference on Vocational Education and Electrical Engineering (ICVEE)*, 2020, pp. 1–6.
- [8] J. C. Shovic, *Raspberry Pi IoT Projects*, Second. Apress, 2021.
- [9] D. Yang, L. Ma, and F. Liao, "An Intelligent Voice Interaction System Based on Raspberry Pi," in *2019 11th International Conference on Intelligent Human-Machine Systems and Cybernetics (IHMSC)*, 2019, pp. 237–240.
- [10] D. D. Prasad, G. J. Mallika, S. U. Farooq, A. Tanmaie, D. R. Krishna, and S. Pramod, "Voice Controlled Home Automation," in *2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC)*, 2021, pp. 673–678.
- [11] D. Wolber, H. Abelson, E. Spertus, and L. Looney, *App Inventor 2: Create Your Own Android Apps*. Sebastopol, CA: O'Reilly Media, 2015.