2019 IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS 2019)

Hsinchu, Taiwan 18-20 March 2019



IEEE Catalog Number: CFP19R18-POD ISBN:

978-1-5386-7885-5

Copyright © 2019 by the Institute of Electrical and Electronics Engineers, Inc. All Rights Reserved

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

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

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

 IEEE Catalog Number:
 CFP19R18-POD

 ISBN (Print-On-Demand):
 978-1-5386-7885-5

 ISBN (Online):
 978-1-5386-7884-8

Additional Copies of This Publication Are Available From:

Curran Associates, Inc 57 Morehouse Lane Red Hook, NY 12571 USA Phone: (845) 758-0400 Fax: (845) 758-2633

E-mail: curran@proceedings.com Web: www.proceedings.com





Table of Contents

Message from the Honorary Chair and General Co-Chairsi
Message from Technical Program Co-Chairs iii
Organizing Committeev



IEEE International Conference on Artificial Intelligence Circuits and Systems

Papers by session

SS01	Special Session 1 Smart Circuit Techniques for Neural Networks
Auto Generation Yang Zhao*, Zhongxi	• •
Sub-Word Paralle	
SS01.3On-chip Learning	
Memristor Emula Hussein Assaf*1, Yvo ¹Polytechnique Mont	tors for an Adaptive DPE Algorithm: Comparative Study n Savaria ¹ , Mohamad Sawan ^{1,2} real, Canada a and Westlake Institute for Advanced Study, China
L1	Lecture Session 1 Deep Neural Network for Computer Vision
Deep Multi-Scale Min-Hui Lin ¹ , Chia-Ha ¹ National Sun Yat-sea ² National Taiwan No	Residual Learning-based Blocking Artifacts Reduction for Compressed Images ung Yeh ^{1,2} , Chu-Han Lin ¹ , Li-Wei Kang* ³ , Chih-Hsiang Huang ¹ n University, Taiwan rmal University, Taiwan versity of Science and Technology, Taiwan
Complexity Redu	20 ction on HEVC Intra Mode Decision with modified LeNet-5
Fast event-driver	Iniversity, Taiwan

Slasher: Stadiu	m racer for end-to-end event-based camera autonomous driving experiments
Yuhuang Hu*, Hon	g Ming Chen, Tobi Delbruck
University of Zurich	h and ETH Zurich, Switzerland
L2	Lecture Session 2
	Hardware Accelerators for Al
	34
A CMOS-based	Resistive Crossbar Array with Pulsed Neural Network for Deep Learning Accelerator
	gyun Gi, Jung-gyun Kim, Byung-geun Lee
•	l Engineering and Computer Sicence e of Science and Technology (GIST), Korea
	38
	nergy Efficient Memory-Centric Convolutional Neural Network Processor Architecture
	rongryeol Bong, Donghyeon Han, Hoi-Jun Yoo
KAIST, Korea	ongrycol Bong, Bongnycon Hun, Horsun Too
	42
	cient Accelerator with Relative-Indexing Memory for Sparse Compressed Convolutional
Neural Network	
I-Chen Wu¹, Po-Tsa	ang Huang*², Chin-Yang Lo¹, Wei Hwang¹,²
	ectronics Engineering, National Chiao Tung University, Taiwan
² International Colle	ege of Semiconductor Technology, National Chiao Tung University, Taiwan
L2.4	46
Accelerator Des	sign for Vector Quantized Convolutional Neural Network
Yi-Heng Wu*, Heng	g Lee, Yu Sheng Lin, Shao-Yi Chien
National Taiwan U	niversity, Taiwan
SS02	Special Session 2
	Edge and Fog Computing to Enable AI in IoT
	51
9 9	Computing enabled AI for Internet of Things
¹ Fudan University,	Paavo Nevalainen², Yuxiang Huan¹, Jukka Heikkonen², Tomi Westerlund²
² University of Turk	
SS02 2	57
	sion-Scalable Multiply-Accumulate Units for Neural-Network Processing
- Vincent Camus* ^{1,2} ,	. Christian Enz¹, Marian Verhelst²
¹ ICLAB, EPFL, Switz	
² ESAT-MICAS, KU L	euven, Belgium

	62	
Towards Work	kload-Balanced, Live Deep Learning Analytics for Confidentiality-Aware IoT Medical Platforn	าร
	Haoming Chu, Zhuo Zou, Lirong Zheng	
Fudan University,		
	67 ligence of Things Wearable System for Cardiac Disease Detection	'
Yu-Jin Lin ¹ , Chen-	-Wei Chuang¹, Chun-Yueh Yen¹, Sheng-Hsin Huang¹, Peng-Wei Huang¹, Ju-Yi Chen², Shuenn-Yuh Lee*¹	
	Electrical Engineering, National Cheng Kung University, Taiwan iology, Department of Internal Medicine, National Cheng Kung University Hospital, College of Medicine, National Taiwan	Cheng
L3	Lecture Session 3 Neuromorphic Processors	
131	71	
	ing and Recognition of Visual Patterns in Neuromorphic Electronic Agents	
-	*, Raphaela Kreiser, Carsten Nielsen, Ning Qiao, Yulia Sandamirskaya, Giacomo Indiveri ich and ETH Zurich, Switzerland	
L3.2	76)
	DropConnect for Reliable Neuromorphic Inference under Energy and Bandwidth Network Connectivity	
Yasufumi Sakai*¹	^{1,2} , Bruno Umbria Pedroni², Siddharth Joshi³, Abraham Akinin², Gert Cauwenberghs²	
	ories Ltd. lifornia, San Diego, La Jolla, USA otre Dame, Notre Dame, USA	
L3.3	81	I
Conversion of sigma-delta q	f Synchronous Artificial Neural Network to Asynchronous Spiking Neural Network using uantization	
	zadeh¹, Sahar Hosseini², Priscila Holanda¹, Sam Leroux¹, Thilo Werner¹, Teresa Serrano-Gotarredona², Bernabe *², Bart Dhoedt¹, Pieter Simoens¹	
	y-imec, IDLab, Belgium roelectronica de Sevilla (CSIC and Univ. de Sevilla), Sevilla, Spain	
	8 <i>6</i>)
•	c networks using silicon retina on the SpiNNaker platform	
_	*1,2, Francesco Galluppi², Xavier Lagorce², Ryad Benosman²,3	
² Institut de la Vis	roinformatics, Unversity of Zurich and ETH Zurich, Switzerland sion, Sorbonne Universite, France tsburgh, Medical Center, USA	
L4	Lecture Session 4 Application Specific AI Accelerators	
	Application specific At Accelerators	
	92)
A Flexible and Applications	I High-Performance Self-Organizing Feature Map Training Acceleration Circuit and Its	
Yu-Hsiu Sun, Tzi-E		
National Taiwan	University, Taiwan	

L4.297
A 2.17mW Acoustic DSP Processor with CNN-FFT Accelerators for Intelligent Hearing Aided Devices
Yu-Chi Lee¹, Tai-Shih Chi², Chia-Hsiang Yang*1,3
¹ Graduate Institute of Electronics Engineering, National Taiwan University, Taiwan ² National Chiao Tung University, Taiwan ³ Department of Electrical Engineering, National Taiwan University, Taiwan
L4.3
Kai-Yen Wang*, Yu-De Huang, Yun-Lung Ho, Nicolas Fahier, Wai-Chi Fang National Chiao Tung University, Taiwan
L4.4 107 Context-Preserving Filter Reorganization for VDSR-Based Super-resolution
Donghyeon Lee ¹ , Sangheon Lee ¹ , Ho Seong Lee ¹ , Kyujoong Lee ^{*2} , Hyuk-Jae Lee ¹
¹Seoul National University, Korea ²Sunmoon University, Korea
SS03 Special Session 3 Analytics Algorithm/Architecture for Smart System Design
SS03.1
A Framework for Design and Implementation of Adaptive Digital Predistortion Systems
Lin Li*1, Peter Deaville ¹ , Laurri Anttila ² , Mikko Valkama ² , Adrian Sapio ¹ , Marilyn Wolf ³ , Shuvra Bhattacharyya ^{1,2} ¹ University of Maryland College Park, USA ² Tampere University, Finland ³ Georgia Institute of Technology, USA
SS03.2 117 Reconfigurable Edge via Analytics Architecture
Shih-Yu Chen* ¹ , Gwo Giun (Chris) Lee ¹ , Tai-Ping Wang ² , Chin-Wei Huang ¹ , Jia-Hong Chen ¹ , Chang-Ling Tsai ³ ¹ National Cheng Kung University, Taiwan ² ASE Group Inc., Taiwan ³ University of Washington, USA
SS03.3
Improved Hybrid Memory Cube for Weight-Sharing Deep Convolutional Neural Networks
Hao Zhang, Jiongrui He, Seok-Bum Ko* University of Saskatchewan, Canada
SS03.4
Function-Safe Vehicle AI Processor with Nano Core-in-Memory Architecture
Youngsu Kwon*, Jeongmin Yang, Yongcheol Peter Cho, Kyoung-Seon Shin, Jaehoon Chung, Jinho Han, Chun-Gi Lyuh, Hyun-Mi Kim, Chan Kim, Min-Seok Choi
Al Processor Research Group, Electronics and Telecommunications Research Institute, Korea

IEEE International Conference on Artificial Intelligence Circuits and Systems

SS03.5	- 132
Fast Detection of Objects Using a YOLOv3 Network for a Vending Machine	102
YOUHAK LEE*1, Chulhee Lee1, Jinsung Kim², Hyuk-Jae Lee1	
¹ Seoul National University, Korea	
Sunmoon University, Korea	

L5 Lecture Session 5

Deep Learning for Speech and Low-dimensional Signal Processing

Deep Learning for Speech and Low annersional Signar Freecosing	
L5.1	137
Hyperdimensional Computing-based Multimodality Emotion Recognition with Physiological Signals	
En-Jui Chang*1, Abbas Rahimi ¹ , Luca Beninia ² , An-Yeu (Andy) Wu ³ Untegrated System Laboratory, ETH Zurich, Switzerland University of Bologna, Italy National Taiwan University, Taiwan	
L5.21	142
Design of Intelligent EEG System for Human Emotion Recognition with Convolutional Neural Network	
Kai-Yen Wang*, Yun-Lung Ho, Yu-De Huang, Nicolas Fahier, Wai-Chi Fang National Chiao Tung University, Taiwan	
L5.3Sparse Autoencoder with Attention Mechanism for Speech Emotion Recognition	146
Ting-Wei Sun, An-Yeu (Andy) Wu National Taiwan University, Taiwan	
	150
A Pruned-CELP Speech Codec Using Denoising Autoencoder with Spectral Compensation for Quality and Intelligibility Enhancement	100
Yu-Ting Lo¹, Syu-siang Wang², Yu Tsao², Sheng-Yu Peng¹*	
National Taiwan University of Science and Technology, Taiwan PAcademia Sinica, Taiwan	
L5.51	152
An Enhanced MUSIC DoA Scanning Scheme for Array Radar Sensing in Autonomous Movers	
Kuang-Ying Chang, Kuan-Ting Chen, Wei-Hsuan Ma*, Yin-Tsung Hwang	
National Chung Hsing University, Taiwan	
MERL, USA	

IEEE International Conference on Artificial Intelligence Circuits and Systems

SF	Special Session/Forum 2018 Low-Power Image Recognition Challenge and Beyond
2018 Low-Power Matthew Ardi ¹ , Alexa Yang Lu ⁷ , Yung-Hsian ¹ Purdue University; ² L ³ Google; ⁴ Intel, USA	ul National University
L6	Lecture Session 6 Medical AI (I)
Novel Sleep Apne Chiapin Wang*1.4, Jen ¹National Taiwan Nor ²Department of Electi ³Department of Mech ⁴MOST Joint Research L6.2 Machine Learning Chiapin Wang*1.4, Tsu ¹National Taiwan Nor ²Department of Electi ³Department of Mech ⁴MOST Joint Research L6.3 Epilepsy Identifica	a Detection Based on UWB Artificial Intelligence Mattress -Hau Chan¹, Shih-Hau Fang².⁴, Ho-Ti Cheng², Yeh-Liang Hsu³ mal University, Taiwan ical Engineering, Yuan Ze University, Taiwan anical Engineering and Gerontechnology Research Center, Yuan Ze University, Taiwan Center for Al Technology and All Vista Healthcare, Taiwan
IN01	Industrial Session 1 Al Computing Platform
NeuroPilot: A Cro	

MediaTek Inc.

Multi-task ADA	AS system on FPGA	
Jinzhang Peng¹, L	u Tian*2,1, Xijie Jia¹, Haotian Guo¹, Yongsheng Xu¹, Dongliang Xie¹, Hong Luo¹, Yi Shan¹, Yu Wang²	
Xilinx,Inc.		
² Department of E	lectronic Engineering, Tsinghua University	
SS04	Special Session 4	
	Intelligent processing of time-series signals	
SS04.1		175
Classification of	of Cardiac Arrhythmias Based on Artificial Neural Networks and Continuous-in-Time	
Discrete-in-Am	nplitude Signal Flow	
Yang Zhao*, Simo	on Lin, Zhongxia Shang, Yong Lian	
EECS, Lassonde So	chool of York University	
2204.2		170
	nvolutional Neutral Network Based Detector Model for Small Visual Object	1/9
	Autonomous Driving	
Shijin Sona*1. Yon	ngxin Zhu ^{1,2} , Junjie Hou ¹ , Yu Zheng ¹ , Tian Huang ³ , Sen Du ¹	
-	ectronics, Shanghai Jiao Tong University, China	
² Shanghai Advand	ced Research Institute, Chinese Academy of Sciences, China	
³ University of Can	nbridge, United Kingdom	
SS04.3		184
Accelerating C	NN-RNN Based Machine Health Monitoring on FPGA	
Xiaoyu Feng*, Jins	shan Yue, Qingwei Guo, Huazhong Yang, Yongpan Liu	
Tsinghua Universi	ty, China	
SS04.4		189
Heart Rate Est	timation from Ballistocardiogram Using Hilbert Transform and Viterbi Decoding	
Qingsong Xie, Yor	ngfu Li, Guoxing Wang*, Yong Lian	
Shanghai Jiao Ton	ng University, China	
L7	Lecture Session 7	
	Medical AI (II)	
		194
Automatic HC0	C Detection Using Convolutional Network with Multi-Magnification Input Images	
Wei-Che Huang¹, Shih-Hsuan Lin¹	Pau-Choo Chung ¹ , Hung-Wen Tsai ² , Nan-Haw Chow ³ , Ying-Zong Juang ⁴ , Cheng-Hsiung Wang ^{*4} , Hann-H	uei Tsai ⁴ ,
	Kung University, Taiwan	u Tairran
³ College of Medic	athology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung Universit ine, National Cheng Kung University, Taiwan ductor Research Institute, National Applied Research Laboratories, Taiwan	y, iuiwan

IEEE International Conference on Artificial Intelligence Circuits and Systems

L7.2	- 199
Using a Cropping Technique or Not: Impacts on SVM-based AMD Detection on OCT Images	
Cheng-En Ko*1, Po-Han Chen1, Wei-Ming Liao1, Cheng-Kai Lu2, Cheng-Hung Lin1, Jing-Wen Liang1	
¹ Yuan Ze University, Taiwan ² Universiti Teknologi PETRONAS, Malaysia	
L7.3	- 201
AI-Based Edge-Intelligent Hypoglycemia Prediction System Using Alternate Learning and Inference Method for Blood Glucose Level Data with Low-periodicity	
Tran Minh Quan ¹ , Takuyoshi Doike ¹ , Dang Cong Bui ¹ , Kenya hayashi ¹ , Shigeki Arata ¹ , Atsuki Kobayashi ¹ , Md. Zahidul Kiichi Niitsu ^{*1,2}	Islam¹,
¹ Nagoya University, Japan ² PRESTO, JST, Japan	
L7.4	- 207
A Deep Learning Based Wearable Medicines Recognition System for Visually Impaired People	
Wan-Jung Chang ^{1,2} , Yue-Xun Yu ¹ , Jhen-Hao Chen ¹ , Zhi-Yao Zhang ¹ , Sung-Jie Ko ¹ , Tsung-Han Yang ¹ , Chia-Hao Hsu ^{1,2} , Liang-Bi Chen* ^{1,2} , Ming-Che Chen ^{2,1}	
¹ Southern Taiwan University of Science and Technology, Taiwan	
² Artificial Intelligence over Internet of Things Applied Research Center (AloT Center),	
Southern Taiwan University of Science and Technology, Taiwan	

IN02 Industrial Session 2 Compiler Technology for AI Chip

PI	Applications of Deep Neural Network	
P1.1		219
Huang-Yu Yao*, Hs	tform for Robot Navigation based on a Brain-Inspired Spiking Neural Network suan-Pei Huang, Yu-Chi Huang, Chung-Chuan Lo a University, Taiwan	
	nmanned Smart Logistics Prototype System Design and Implementation	221
¹ GMT Global Inc.	ectronics of Feng Chia University, Taiwan,	
		225
Tong-Yu Hsieh*, Yu	Generation of Training Images for Machine Learning in Automotive Applications Jan-Cheng Lin, Hsin-Yung Shen Jen University, Taiwan	
		229
•	y Detection in HPC Systems	
¹ University of Bolo ² IIS, ETHZ, Zurich,		
P2	Poster Session 2 Algorithms and Architectures for Neural Networks	
P2.1		234
Configurable Te	exture Unit for Convolutional Neural Networks on Graphics Processing Units	
Yi-Hsiang Chen*, S National Taiwan U		
Implementation Comparator Me Sang-Gyun Gi*, Inj	june Yeo, Byung-geun Lee	239
Gwangju Institute	of Science and Technology, South Korea	
Heterogeneous	s activation function extraction for training and optimization of SNN systems	244
	ret Kumar, Rene van Leuken Technology, The Netherlands	
Performance Ti Pablo M. Tostado,	rade-offs in Weight Quantization for Memory-Efficient Inference Bruno U. Pedroni, Gert Cauwenberghs ornia San Diego, USA	246

IEEE International Conference on Artificial Intelligence Circuits and Systems

P2.5Elastic Neural Networks for Classification	- 251
Yi Zhou*1, Yue Bai ¹ , Shuvra S. Bhattacharyya ^{1,2} , Heikki Huttunen ¹ ¹Tampere University of Technology, Finland ²University of Maryland, USA	
P2.6Optimizations of Scatter Network for Sparse CNN Accelerators	- 256
Sunwoo Kim ¹ , Chungman Lee ¹ , Haesung Park ¹ , Jooho Wang ¹ , Sungkyung Park ² , Chester Sungchung Park ^{*1} ¹ Konkuk University, Korea ² Pusan National University, Korea	
P2.7Fast Convolution Algorithm for Convolutional Neural Networks	- 258
Tae Sun Kim, JiHoon Bae, Myung Hoon Sunwoo* Ajou University, Korea	

SS05 Special Session 5 Emerging Memory Technologies for Neuromorphic Circuits and Systems

SS05.1
SS05.2
Jason Eshraghian *1, Sung-Mo Kang², Seungbum Baek³, Garrick Orchard⁴, Herbert Ho-Ching Iu¹, Wen Lei¹¹¹University of Western Australia ²University of California, USA ³Chungbuk National University, Korea ⁴National University of Singapore, Singapore
SS05.3
Olga Krestinskaya, Adilya Bakambekova, Alex Pappachen James* Nazarbayev University, Kazakhstan
SS05.4
Olga Krestinskaya, Otaniyoz Otaniyozov, Alex Pappachen James*

IEEE International Conference on Artificial Intelligence Circuits and Systems

L8	Lecture Session 8 Low Precision Neural Network	
L8.1		
Exploration of Automatic Mixed-Precision Search for Deep Neural Networks		
Xuyang Guo¹, Yua	njun Huang*², Hsin-Pai Cheng³, Bing Li³,⁵, Wei Wen³, Siyuan Ma⁴, Hai Li³, Yiran Chen³	
¹ Tsinghua Univers ² University of Scie ³ Duke University, ⁴ Xi'an Jiaotong Un	ence and Technology of China, China USA	
	Office, Research Triangle Park, USA	
	27	'9
Extended Bit-P	Plane Compression for Convolutional Neural Network Accelerators	
Lukas Cavigelli*, L		
ETH Zurich, Switze	erland	
		34
	ight Indexing Scheme for Memory-Reduced Convolutional Neural Network	
	ungsik Moon, Younghoon Byun, Sunggu Lee, Youngjoo Lee* v of Science and Technology (POSTECH), Korea	
2011	28	38
Outstanding B	it Error Tolerance of Resistive RAM-Based Binarized Neural Networks	
Tifenn Hirtzlin¹, N ¹Univ Paris-Sud, F ²Univ Aix-Marseill ³CEA, LETI, France	le, France	
SS06	Special Session 6	
	AI in Advanced Applications	
SS06.1)3
	ecture Style Transfer for Ruin Buildings	J
Chia-Ching Wang	¹ , Hsin-Hua Liu², Soo-Chang Pei², Kuan-Hsien Liu³, Tsung-Jung Liu*¹	
² National Taiwan	Hsing University, Taiwan University, Taiwan a University of Science and Technology. Taiwan	

Age Estimation on Low Quality Face Images

²National Taiwan University, Taiwan ³National Chung Hsing University, Taiwan

¹National Taichung University of Science and Technology, Taiwan

Kuan-Hsien Liu*1, Hsin-Hua Liu², Soo-Chang Pei², Tsung-Jung Liu³, Chun-Te Chang¹

SIFT Features and SVM Learning based Sclera Recognition Method with Efficient Sclera Segmentation for Identity Identification		
Sheng-Yu He, Chih-Peng Fan* National Chung Hsing University, Taiwan		
SS06.4 Low Precision Electroencephalogram for Seizure Detection with Convolutional Neural Network		
Nhan Truong*, Omid Kavehei University of Sydney, Australia		
L9 Lecture Session 9 Hardware Oriented Neural Network Optimization		
L9.1 Intelligent Policy Selection for GPU Warp Scheduler Lih-Yih Chiou*1, Tsung-Han Yang¹, Jian-Tang Syu¹, Che-Pin Chang¹, Yeong-Jar Chang² ¹ National Cheng Kung University, Taiwan ² Industrial Technology Research Institute, Taiwan	302	
L9.2SMURFF: a High-Performance Framework for Matrix Factorization Tom Vander Aa*, Imen Chakroun, Thomas J. Ashby Imec, , Belgium	304	
L9.3Spatial Data Dependence Graph Simulator for Convolutional Neural Network Accelerators Jooho Wang¹, Jiwon Kim¹, Sungmin Moon¹, Sunwoo Kim¹, Sungkyung Park², Chester Sungchung Park*¹ Sonkuk University Pusan National University	309	
L9.4AIP: Saving the DRAM Access Energy of CNNs Using Approximate Inner Products Cheng-Hsuan Cheng, Ren-Shuo Liu* National Tsing Hua University, Taiwan	311	
Author Index	3	