Workshop on TinyML for Sustainable Development

Marco Zennaro,
mzennaro@ictp.it

Thanks!

Bruno Flach
Raquel Zarattini Chebabi
Rodrigo Neumann Barros Ferreira
The whole IBM Brazil team!

TinyML Academic Network

http://tinymledu.org

We aim to develop a **community** of researchers and practitioners focused on both **improving access** to TinyML education and enabling **innovative solutions** for the unique challenges faced by Developing Countries.

Joint workshops and seminars on TinyML

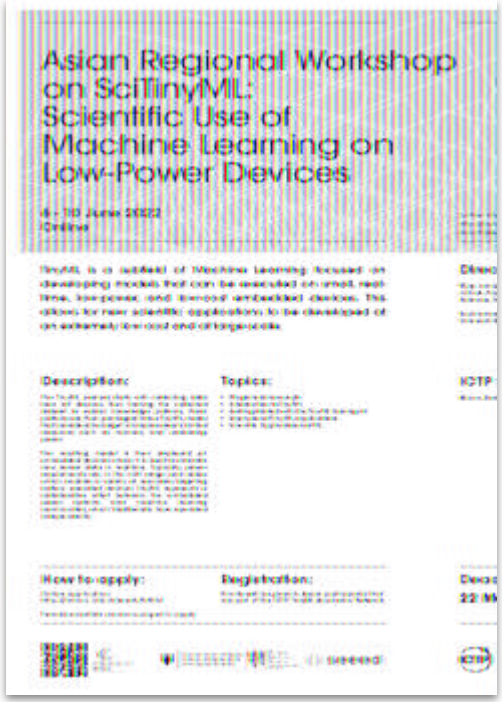
An online forum to consolidate the TinyML community

Open exchange of student projects, lesson plans, real-world deployments and outreach materials

TEC - Monterrey
UVG - Guatemala
UNA - Heredia
UDI - David
UAO - Cali
PUJ - Bogotá
ESPOL - Guayaquil
UTP - Piura
UPCH - Lima
UCB - La Paz
INATEL - Santa Rita do Sapucaí
UFV - Viçosa
UTFPR - Curitiba
UNIFEI - Itajubá
IFSP - São Paulo
UDD - Santiago
FURG - Rio Grande
CAB - Bariloche
UNTDF - Ushuaia
ITU - Istanbul
AUI - Ifrane
ASU - Giza
KFU - AlAhsa
ITU - Lahore
ISI - Kolkata
MIT-WPU - Pune
USTC - Chittagong
KIC - Kobe
ATRIA - Bangalore
AIT - Pathum Thani
BDU - Bahir Dar
VIT - Chennai
HCMIP - Ho Chi Minh city
UAC - Porto-Novo
AUST - Abuja
AAU - Addis Ababa
UKM - Selangor
UTM - Johor
UR - Kigali
DeKUT - Nyeri
UTU - Windhoek West
WITS - Johannesburg
UJ - Johannesburg

2021: 210 participants from 48 countries

2022: 187 participants
29 African countries



2022: 100 participants
8 Asian countries

2022: 183 participants
17 LatAm countries

Workshop on Scientific Use of Machine Learning on Low-Power Devices: Applications and Advanced Topics

ICTP

17 - 21 April 2023
An ICTP Virtual Meeting
Trieste, Italy

Further information:
http://indico.ictp.it/event/10164/
wm2023@ictp.it

TinyML is a subfield of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed at an extremely low cost and at large scale.

Directors:

B. PLANCHER, Barnard College, USA
V. J. REDDI, Harvard University, USA
M. BOVAI, Federal University of Itajubá, Brazil

Description:

TinyML represents a collaborative effort between the embedded power systems and Machine Learning communities, which traditionally have operated independently.

TinyML has a significant role to play in achieving the SDGs and facilitating scientific research in areas such as environmental monitoring, physics of complex systems and energy management.

The TinyML process starts with collecting data from IoT devices, then training the collected dataset to extract knowledge patterns; these patterns are then packaged into a TinyML model that considers the target microprocessor's limited resources such as memory, processing power, and energy.

Through hands-on examples, this workshop will focus on both introductory and advanced topics in TinyML to pave the way to the development of real-world applications.

Topics:

- Introduction to TinyML
- Getting Started with the TinyML Kit
- Examples of TinyML Applications
- The TinyML Development Workflow
- Scientific Applications of ML
- Recent Research and Advanced Topics in TinyML

Local Organiser:

M. ZENNARO, ICTP, Italy

How to apply:

Online application:
http://indico.ictp.it/event/10164/

Female scientists are encouraged to apply.

Registration:

There is no registration fee.

Deadline:

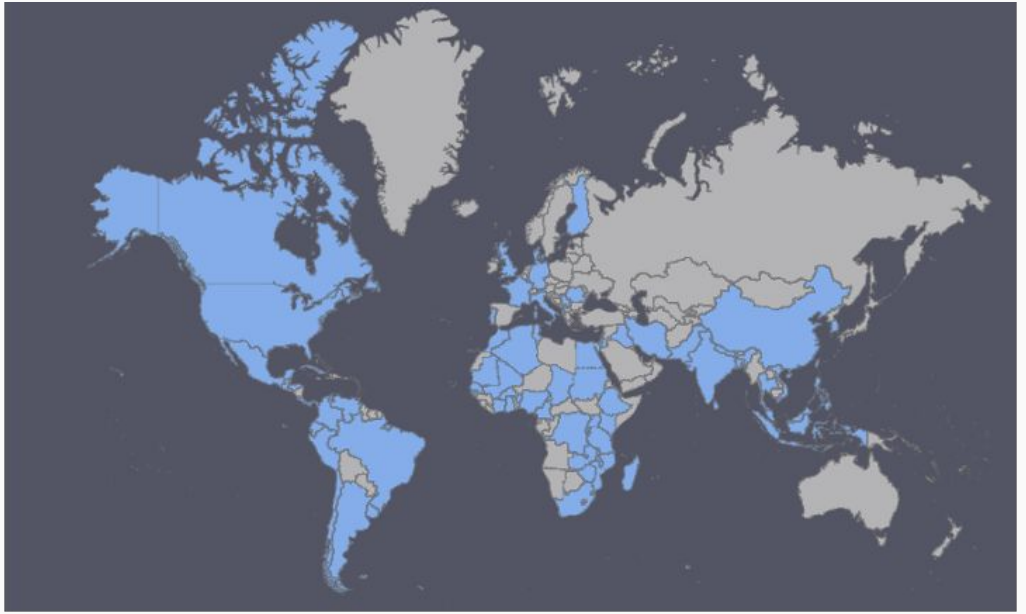
7 April 2023

BARNARD

Harvard John A. Paulson School of Engineering and Applied Sciences

UNIFEI

ICTP The Abdus Salam International Centre for Theoretical Physics
www.ictp.it
Trieste, Italy



2023: 418 participants from 72 countries

Macau
April 2024

Online,
May 2024

Brazil,
July 2024

Timothy Kudzanayi Kuhamba

Thanx Marisa[a*], Munyaradzi Munochiveyi[a*], Wadzanai Julius Zondai[a*], Ramson Munyaradzi Nyamukondiwa[a] , Isheanesu Newengo[b]

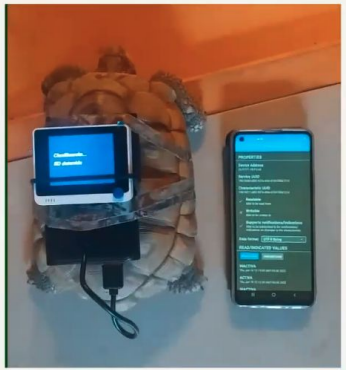
Case Study Zimbabwe

A DEEP LEARNING BASED APPROACH FOR FOOT AND MOUTH DISEASE DETECTION

AFRICAN CENTER OF EXCELLENCE IN INTERNET OF THINGS

TinyML Based Self Diagnostic Kit for Respiratory Diseases

Samson Otieno Ooko



Collect Data | Preproc Data | Optimize | Make Inferences

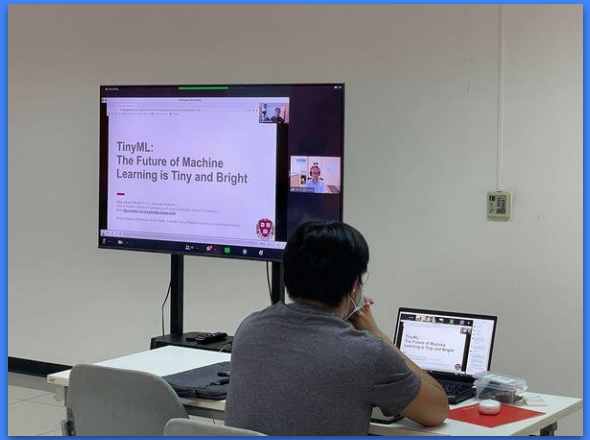
pantalla cambia de color ya que detecta que la

VEGETABLE DISEASE AND INSECT PEST RECOGNITION BASED ON TINYML:
Cotton Case in Benin

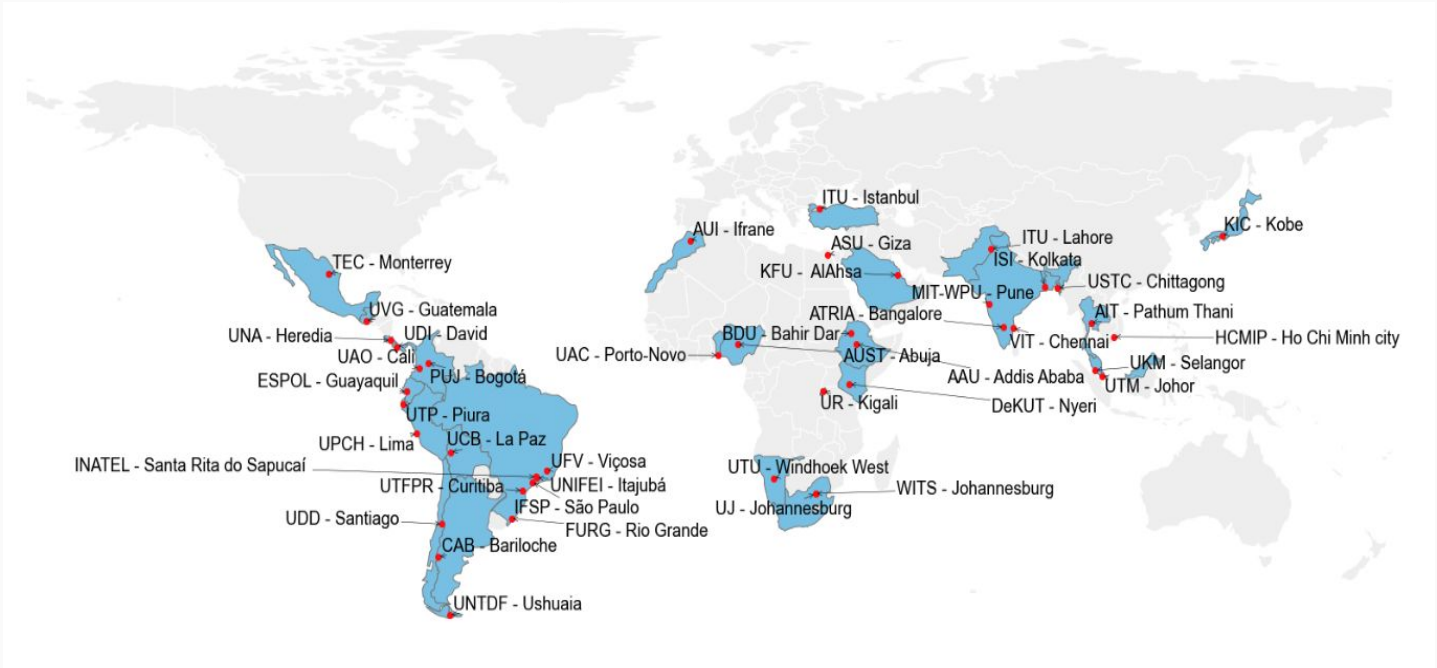
James O. ADEOLA
IMSP - UAC

Dr Marco Zenaro
ICTP Italy

Dr Jules DEGILA
IMSP Benin


TinyML:
The Future of Machine
Learning is Tiny and Bright

Networking


ITU - Istanbul
AUI - Ifrane
ASU - Giza
KFU - AlAhsa
ITU - Lahore
ISI - Kolkata
MIT-WPU - Pune
USTC - Chittagong
KIC - Kobe
ATRIA - Bangalore
AIT - Pathum Thani
BDU - Bahir Dar
VIT - Chennai
HCMIP - Ho Chi Minh city
UAC - Porto-Novo
AUST - Abuja
AAU - Addis Ababa
UKM - Selangor
UTM - Johor
UR - Kigali
DeKUT - Nyeri
TEC - Monterrey
UVG - Guatemala
UNA - Heredia
UDI - David
UAO - Cali
PUJ - Bogotá
ESPOL - Guayaquil
UTP - Piura
UPCH - Lima
UCB - La Paz
INATEL - Santa Rita do Sapucaí
UFV - Viçosa
UTFPR - Curitiba
UNIFEI - Itajubá
IFSP - São Paulo
UDD - Santiago
FURG - Rio Grande
CAB - Bariloche
UNTDF - Ushuaia
UTU - Windhoek West
WITS - Johannesburg
UJ - Johannesburg

Opportunities

1) Join the TinyML Academic Network: edu@tinyml.org

2) Please join Discord by following this link: https://discord.gg/zKWgwhSAEY if you haven't already done so!

We will post **news, opportunities, workshops** only on Discord.

Learning and Teaching

If you want to learn more about TinyML:

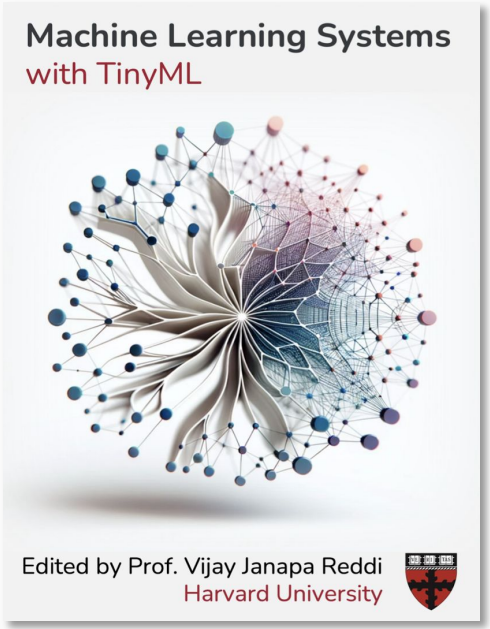
https://tinyMLedu.org/learn

If you want to teach a course on TinyML:

https://tinyMLedu.org/teach

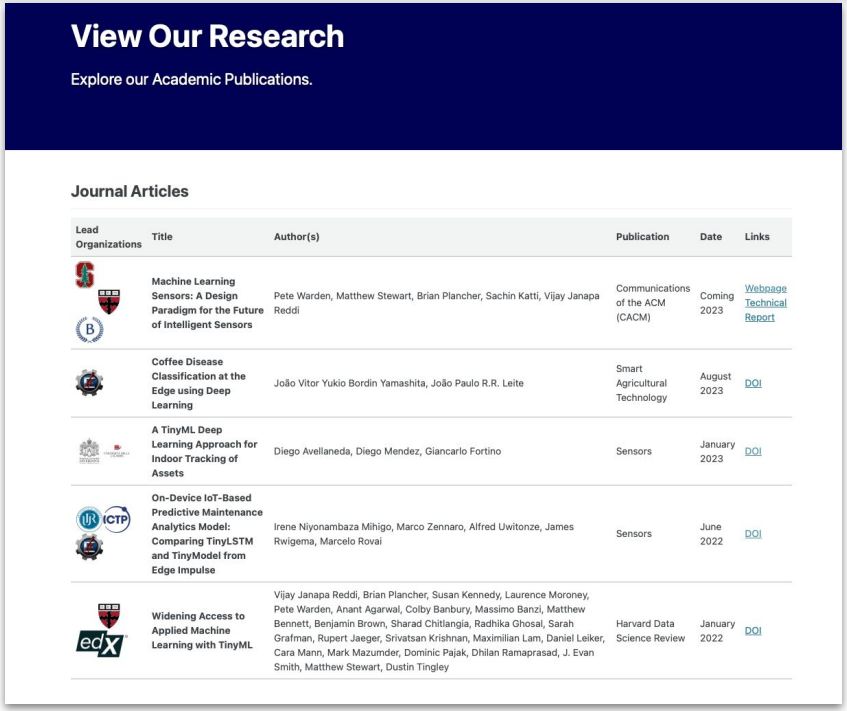
edX tinyML Specialization	Launched 2020-2022	Everyone	English	English	Course 1-3 Website Course 4 Website All Materials All Colabs Arduino Library
UNIFEI IESTI01 TinyML - Machine Learning for Embedding Devices	Jan 2021 - Present	Undergraduate Students	Portuguese	English	2022.1 Website and Materials 2021.2 Website and Materials 2021.1 Website and Materials

Learning and Teaching



https://github.com/harvard-edge/cs249r_book

Research



View Our Research

Explore our Academic Publications.

Journal Articles

Lead Organizations	Title	Author(s)	Publication	Date	Links
	Machine Learning Sensors: A Design Paradigm for the Future of Intelligent Sensors	Pete Warden, Matthew Stewart, Brian Plancher, Sachin Katti, Vijay Janapa Reddi	Communications of the ACM (CACM)	Coming 2023	Webpage Technical Report
	Coffee Disease Classification at the Edge using Deep Learning	João Vitor Yukio Bordin Yamashita, João Paulo R.R. Leite	Smart Agricultural Technology	August 2023	DOI
	A TinyML Deep Learning Approach for Indoor Tracking of Assets	Diego Avellaneda, Diego Mendez, Giancarlo Fortino	Sensors	January 2023	DOI
	On-Device IoT-Based Predictive Maintenance Analytics Model: Comparing TinyLSTM and TinyModel from Edge Impulse	Irene Niyonambaza Mihigo, Marco Zennaro, Alfred Uwitonze, James Rwigema, Marcelo Rovai	Sensors	June 2022	DOI
	Widening Access to Applied Machine Learning with TinyML	Vijay Janapa Reddi, Brian Plancher, Susan Kennedy, Laurence Moroney, Pete Warden, Anant Agarwal, Colby Banbury, Massimo Banzi, Matthew Bennett, Benjamin Brown, Sharad Chitlangia, Radhika Ghosal, Sarah Grafman, Rupert Jaeger, Srivatsan Krishnan, Maximilian Lam, Daniel Leiker, Cara Mann, Mark Mazumder, Dominic Pajak, Dhilan Ramaprasad, J. Evan Smith, Matthew Stewart, Dustin Tingley	Harvard Data Science Review	January 2022	DOI

https://tinyMLedu.org/research/

Research

Mihigo, Irene Niyonambaza, et al. "**On-Device IoT-Based Predictive Maintenance Analytics Model: Comparing TinyLSTM and TinyModel from Edge Impulse**." Sensors 22.14 (2022): 5174.

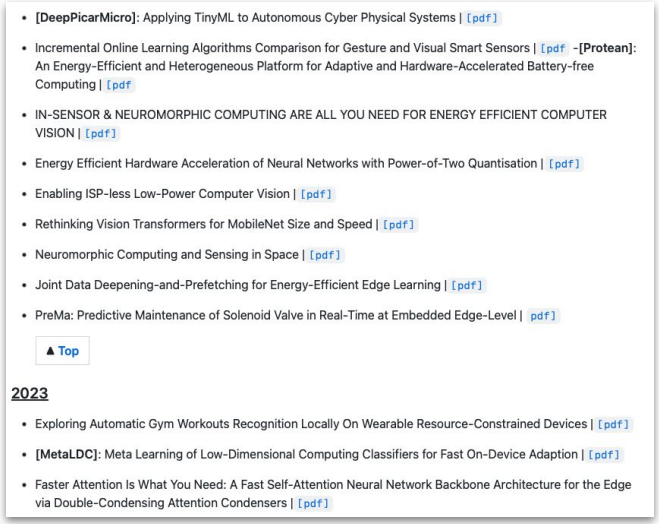
Altayeb, Moez, Marco Zennaro, and Marcelo Rovai. "**Classifying mosquito wingbeat sound using TinyML**." Proceedings of the 2022 ACM Conference on Information Technology for Social Good. 2022.

Bamoumen, Hatim, et al. "**How TinyML Can be Leveraged to Solve Environmental Problems: A Survey.**" 2022 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT). IEEE, 2022.

João Vitor Yamashita et al.. "**Coffee disease classification at the edge using deep learning**". Smart Agricultural Technology Volume 4, August 2023, 100183

G. Silva, M.D. Lima, J.A.F. Filho and M.J. Rovai **"Atrial Fibrillation and Sinus Rhythm detection using TinyML (Embedded Machine Learning).** “IX Latin American Congress on Biomedical Engineering” and “XXVIII Brazilian Congress on Biomedical Engineering”

Research



- **[DeepPicarMicro]**: Applying TinyML to Autonomous Cyber Physical Systems | [pdf]
- Incremental Online Learning Algorithms Comparison for Gesture and Visual Smart Sensors | [pdf] -**[Protean]**: An Energy-Efficient and Heterogeneous Platform for Adaptive and Hardware-Accelerated Battery-free Computing | [pdf]
- IN-SENSOR & NEUROMORPHIC COMPUTING ARE ALL YOU NEED FOR ENERGY EFFICIENT COMPUTER VISION | [pdf]
- Energy Efficient Hardware Acceleration of Neural Networks with Power-of-Two Quantisation | [pdf]
- Enabling ISP-less Low-Power Computer Vision | [pdf]
- Rethinking Vision Transformers for MobileNet Size and Speed | [pdf]
- Neuromorphic Computing and Sensing in Space | [pdf]
- Joint Data Deepening-and-Prefetching for Energy-Efficient Edge Learning | [pdf]
- PreMa: Predictive Maintenance of Solenoid Valve in Real-Time at Embedded Edge-Level | pdf]

▲ Top

2023

- Exploring Automatic Gym Workouts Recognition Locally On Wearable Resource-Constrained Devices | [pdf]
- **[MetaLDC]**: Meta Learning of Low-Dimensional Computing Classifiers for Fast On-Device Adaption | [pdf]
- Faster Attention Is What You Need: A Fast Self-Attention Neural Network Backbone Architecture for the Edge via Double-Condensing Attention Condensers | [pdf]

https://github.com/gigwegbe/tinyml-papers-and-projects

Research

IEEE Design&Test

Call For Papers
Special Issue on “tinyML – The ecosystem for next generation ML systems.”

Aim and Scope

tinyML encapsulates and nurtures the fast-growing branch of ultra-low power machine learning technologies and approaches dealing with machine intelligence at the very edge of the cloud. These integrated "tiny" machine learning applications require "full-stack" (hardware, system, software, and applications) solutions including machine learning architectures, techniques, tools, benchmarks, and approaches capable of performing on-device analytics. A variety of sensing modalities (vision, audio, motion, environmental, human health monitoring, etc.) are used with extreme energy efficiency, typically in the single milliwatt (and below) power range, to enable machine intelligence right at the boundary of the physical and digital worlds. We see a new world with trillions of distributed intelligent devices enabled by energy efficient machine learning technologies that sense, analyze, and autonomously act together to create a healthier and more sustainable environment for all! The tinyML ecosystem is fueled by (i) emerging commercial applications and new systems concepts on the horizon; (ii) significant progress on algorithms, networks, and models down to 100 kB and below; and (iii) current low-power applications in vision and audio that are already becoming mainstream and commercially available. Over the last few years, the tinyML ecosystem has grown significantly in terms of research, innovation and products. Several stakeholders from academia, industry and policymakers emerged as key leaders in this field. The objective therefore of this special issue, is to bring together the key stakeholders of the tinyML ecosystem, in presenting the state of the art in tinyML research and innovation, through a set of contributed manuscripts that detail advancements in research and innovation, identifying

Show and Tell

- Addressed to young researchers, students, practitioners
- Informal → not academic

TinymML4D Academic Network 2nd Show and Tell on October 27th, 2022.

The First TinyML4D Show and Tell of student projects was October 27th, 2022. The recorded video is at this Youtube link https://youtu.be/s8_hKpOWUwY 2

Presenting is:

1. Samson Otieno Ooko, University of Rwanda, TinyML Based Self Diagnostic Kit for Respiratory Diseases,10 minutes. Video starts at 4:37
2. Mateus Faria Delangélica, Universidade Federal de Itajubá (UNIFEI), The Impact of TinyML on an Assistive Technology Project in Brazil, 15 minutes. Video starts at 13:48
3. Ezzeldin Ayman Ibrahim Ismail, Universiti Teknologi Malaysia, Anomaly Detection in the Temperature of an AC Motor Using Embedded Machine Learning, 10 minutes. Video starts at 31:12

TinymML4D Academic Network 2nd Show and Tell on December 1st 2022.

The full video is at this Youtube address https://youtu.be/e49pkjnlMlQ 1

Presenters in the order of presentation are:

1. Wong Khai Chiuan, Universiti Teknologi Malaysia Malaysia, Smart Switch Based on Embedded Machine Learning, 10 minutes. Video at 0s here 1
2. Laila Daniela Kazimierski, Centro Atómico Bariloche, Argentina, Study of animal movement: using the TinyML kits for monitoring, 15 minutes Video Starting at 11:13 here.
3. Slimane Larabi, Usthb University, Algérie, Human-Computer Interaction: Hand Gesture Recognition for Mute People Using Tiny Machine Learning, 10 minutes Video at 29:39 here
4. Md Sharif Ahmed and Prabha Sundaravadivel, The University of Texas at Tyler, United States, Automated American Sign Language (ASL) using TinyML, 5 minutes. Video at 44:13 here
5. Jackline Tum, Dedan Kimathi University of Technology, Kenya, Using TinyML to Monitor Bees, 10 minutes. Video at 47.58 here

What do you need more?

Hardware?Books?

Open training material?

Seminars on specific topics? Introductory seminars?

In-person workshops in your country?

How should we stay in touch?

New sensors for the Nicla?