TinyML Journey - contextual awareness for laptop PCs

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About emza

• Founded in 2006 in Israel, with a vision for low power edge computing

• Develops & sells ultra-low power computer vision solutions (HW & SW)

• Acquired by Himax Technologies in 2018. (NASDAQ:HIMX)
The starting point

CES 2019, Intel announced project Athena

Opportunity:

provide contextual understanding in privacy, at low power based on Ai
AI landscape with visual sensing

- **Shapes**
  - Gyroscope & accelerometer
  - Light
  - Motion
- **Objects, humans**
  - Presence
  - Human detection
  - Face detection
- **Identities, emotions**
  - Eye tracking
  - Face orientation
  - Face recognition
  - Face expression
  - Visual sensing
  - Emza
  - HD vision

1mW

10mW

100mW

1000mW

100 MHz

1 GHz

1 GHz

SW solutions

Private domain

Non-private domain
# Human Presence Detection (HPD)

## Use cases

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<th>Wake on approach</th>
<th>User presence</th>
<th>Walk away lock</th>
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<td>Automatic wake up</td>
<td>Classification – humans vs objects</td>
<td>Automatic screen lock – security</td>
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<td>Touchless Hello/Login experience</td>
<td></td>
<td>Automatic screen off – power save</td>
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CES 2020 demo: Wake on Approach
Contextual privacy

Understanding the context and actively improve privacy security

Sensing

Intruder alert

System response

Auto screen blur

Auto screen dim
User engagement detection at low power

Opportunity to extend battery life by 20%
- New concept: user engagement status
- Engaged: frontal face detected
- Not engaged: user is not looking on the display

New classification requirements:
- Yaw angle
- Head classifier

extends battery life with Adaptive dimming

Engaged
- high illumination

Not Engaged
- dimming
Visual sensing in PC – system architecture

- Human presence detection algorithms
- WiseEye1 ULP CV ASIC
- Integrated within the camera module
- Always-on sensing
- User privacy guaranteed

I2C meta data

USB/MIPI HD image

2.2 mm
Real World Challenges

- The Distance / Field of view / execution speed tradeoff
- Faces in the wild
- How can one detect the engagement level?
- Hard illumination condition as the typical environment
Distance / Field of view / speed challenge

Requirements:

Distance: 25-200cm
Horizontal field of view: 70°
Processing: 8-10 FPS
Output: bounding boxes
Moving to Detector

Motivation for detector

• Bounding box (object location)
• User distance estimation (based on face size)
• Tracking (save power)
• Advanced classification options

But,

running SSD on microcontroller in a naïve manner is merely impossible...
Distance / Field of view / FPS challenge

- 96x96 MobileNet TFLM
- 1MB, mW scale
- FoV
- Distance
- Tiling with Mobile net

Cropping with Mobile net
"micro" CV detector pipeline

- Classical ML for fast box proposal
- Deep learning for short distance / within the boxes

Stage 1: Detection

Fast face detector with Classical ML

Stage 2: Classification

Advanced classifiers within the proposed boxes
Putting it all together

Face detection & yaw angle estimation video
And then Covid-19...
Real world variety

Natural user posing
Real world variety

It is not all about Lux, it’s the dynamic range
TinyML in reality
Ai enabled camera module for laptops
The journey has just begun

- TinyML brings value to consumers applications
- Demo is easy
- Getting to deployment level requires a lot of data science and optimization work
- We are in the early days of adoption
- Innovation in algorithms & silicon IP will enable more sophisticated use cases and will accelerate adoption
Thank you
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Automated TinyML

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Compare the benchmarks of our compact models to those of TensorFlow and other leading neural network frameworks.

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Optimized models for embedded applications (e.g. TensorFlow Lite Micro)

Optimized low-level NN libraries (i.e. CMSIS-NN)

Arm Cortex-M CPUs and microNPUs

RTOS such as Mbed OS

Profiling and debugging tooling such as Arm Keil MDK

Application

Support by end-to-end tooling

Connect to high-level frameworks

Connect to Runtime

Stay Connected

@ArmSoftwareDevelopers

@ArmSoftwareDev

Resources: developer.arm.com/solutions/machine-learning-on-arm
TinyML for all developers

Edge Device
- Real sensors in real time
- Open source SDK

Dataset
- Acquire valuable training data securely

Impulse
- Enrich data and train ML algorithms
- Test impulse with real-time device data flows

Test
- Embedded and edge compute deployment options

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Reasoning
Scene understanding, language understanding, behavior prediction

Action
Reinforcement learning for decision making

A platform to scale AI across the industry
Syntiant Corp. is moving artificial intelligence and machine learning from the cloud to edge devices. Syntiant’s chip solutions merge deep learning with semiconductor design to produce ultra-low-power, high performance, deep neural network processors. These network processors enable always-on applications in battery-powered devices, such as smartphones, smart speakers, earbuds, hearing aids, and laptops. Syntiant's Neural Decision Processors™ offer wake word, command word, and event detection in a chip for always-on voice and sensor applications.

Founded in 2017 and headquartered in Irvine, California, the company is backed by Amazon, Applied Materials, Atlantic Bridge Capital, Bosch, Intel Capital, Microsoft, Motorola, and others. Syntiant was recently named a CES® 2021 Best of Innovation Awards Honoree, shipped over 10M units worldwide, and unveiled the NDP120 part of the NDP10x family of inference engines for low-power applications.

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