arm AI

AI Virtual Tech Talks Series

Accelerate Edge AI Creation for a Competitive Edge

SensiML

Bruce Pleat & Chris Knorowski

April 27, 2021

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AI Virtual Tech Talks Series

Date	Title	Host
April 27th	Accelerate Edge AI Creation for a Competitive Edge	SensiML
May 11th	Bringing PyTorch Models to Arm Cortex-M Processors	AITS
May 25th	Optimized C Code Generation for Ultra-efficient tinyML Applications	Imagimob
July	Easy tinyML with Arduino: taking advantage of machine learning right where things are happening	Arduino

Visit: developer.arm.com/solutions/machine-learning-on-arm/ai-virtual-tech-talks

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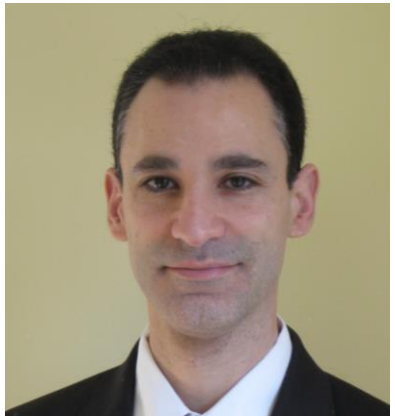
Presenters



Bruce Pleat serves as the Customer Success Manager at SensiML where he is responsible for fostering both new and existing relationships and building long-lasting, customer-centric partnerships. He is a seasoned technology and business professional, and has served in similar roles at both large and small companies including Labelbox, VMware, Wipro, Dow Jones and NASA. He holds an MBA from the University of San Diego and a B.S. in Business from SUNY.

Chris Knorowski is the co-founder and CTO at SensiML where he builds tools to make it easier for developers an engineer's create smart sensor algorithms capable of running at the extreme edge. Prior to SensiML he worked as software engineer and data scientist at Intel and Dupont Pioneer. He holds a Ph.D in computational physics from Iowa State and a B.S. in Physics from Virginia Tech.

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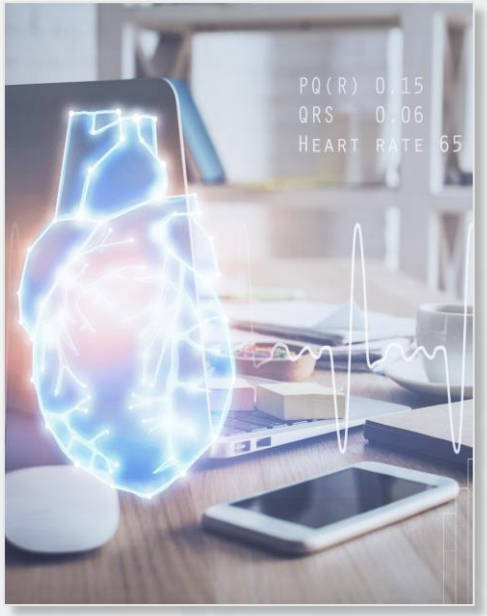
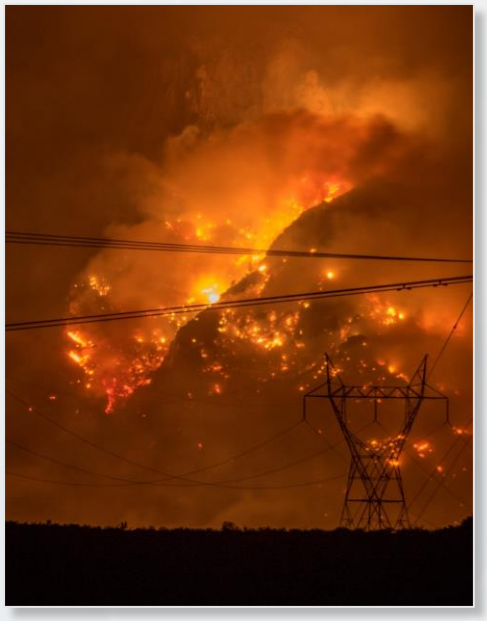
Opportunities: Intersection of AI and Sensing IoT



Health and Wellness

- Aging-in-Place Technology
- Coaching & Rehab Wearables
- Transformative Remote Patient Care



Environmental

- Disaster Prevention & Preparedness
- Data-Driven Resource Conservation

Infrastructure

- Self-Learning Predictive Maintenance
- Ubiquitous Structural Health Monitoring
- Next-Gen AI Process Optimization

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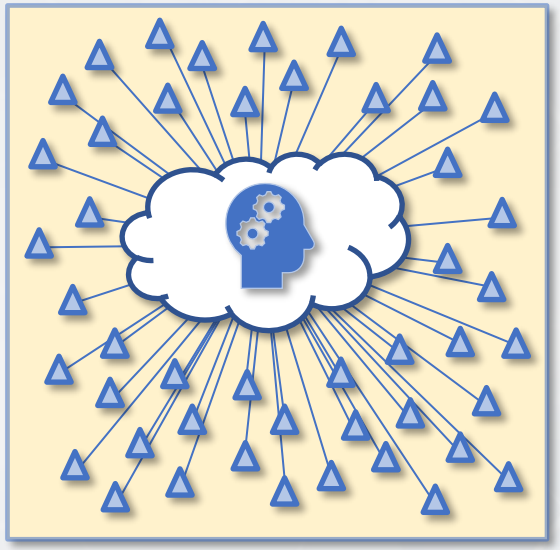
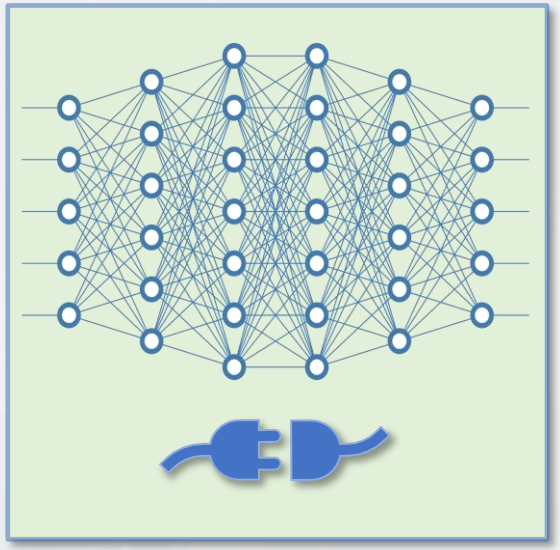
Challenges: Implementing AI for IoT at Scale



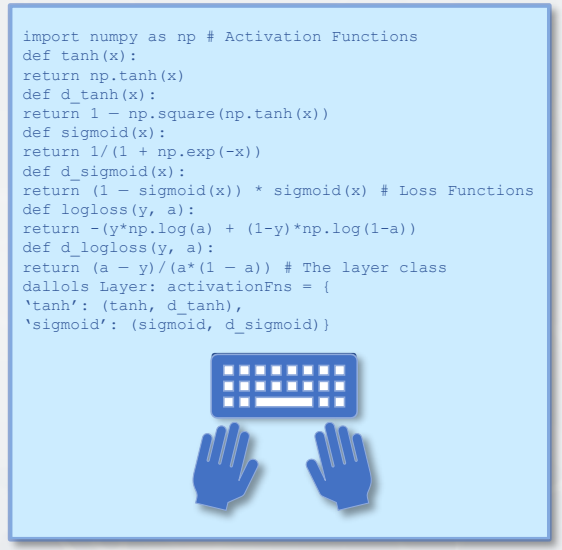
Cloud-Centric AI

- High Network Traffic Load
- High Latency
- Less Fault Tolerant
- Unknown Risk of Data Security
- Concerns of Privacy



Deep Learning

- Large training data requirements
- Large memory footprint
- High processing workload
- High power consumption
- Poor endpoint battery life



Hand-Coded Endpoints

- Slow and labor intensive
- Unknown code size upfront
- Scarce data science expertise
- Complex AI/ML code libraries
- Not scalable / competitive

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SensiML Solves These Challenges:
SensiML Accelerates Edge AI Creation

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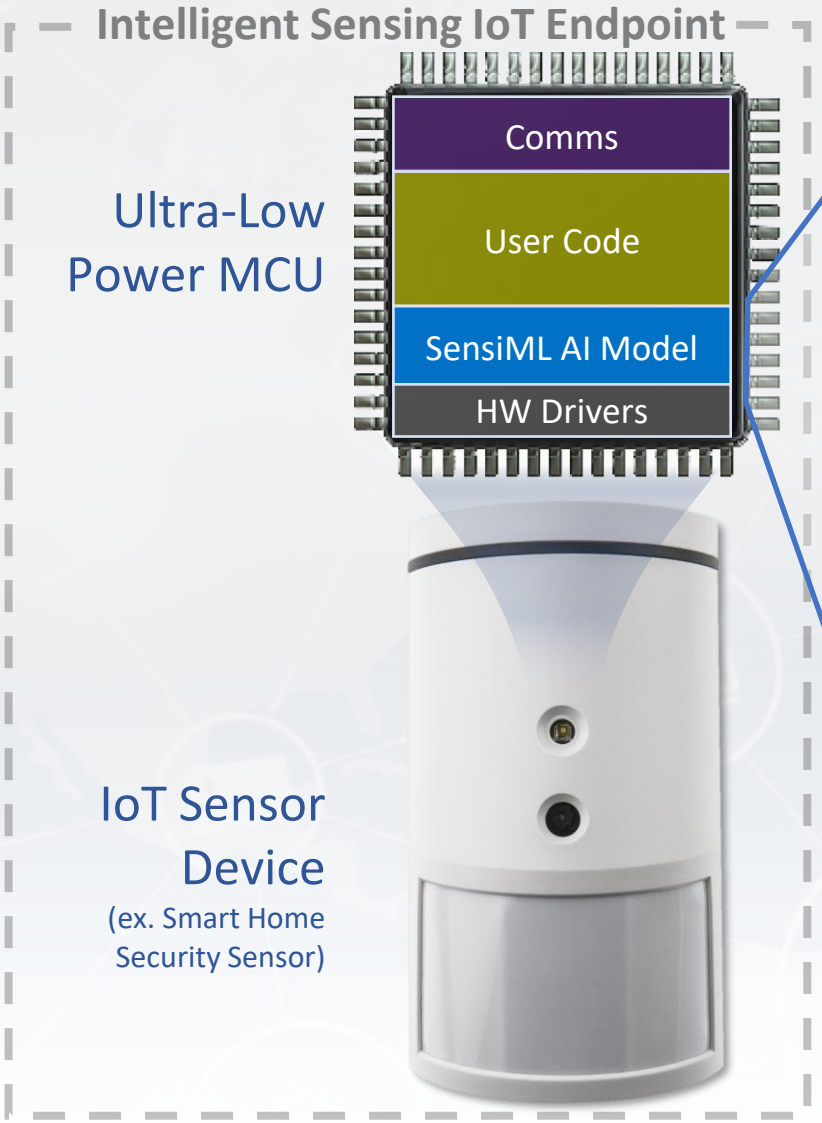
SensiML: Scalable AI for Intelligent IoT Sensing Applications



- **Autonomous endpoint ML models**
  - Optimized to application specific training data and hardware
  - No cloud processing dependencies
  - Local inferencing provides real-time responsiveness
- **Expansive AI library**
  - Classic machine learning (ML) up through deep learning
  - Auto-optimizer selects best model for the application data provided
  - Models as small as 16KB
- **Hand-coding not required**
  - SensiML auto-generates model code
  - Saves months of development effort, and data science expertise
  - Developer can alter any aspect of the automated code as desired

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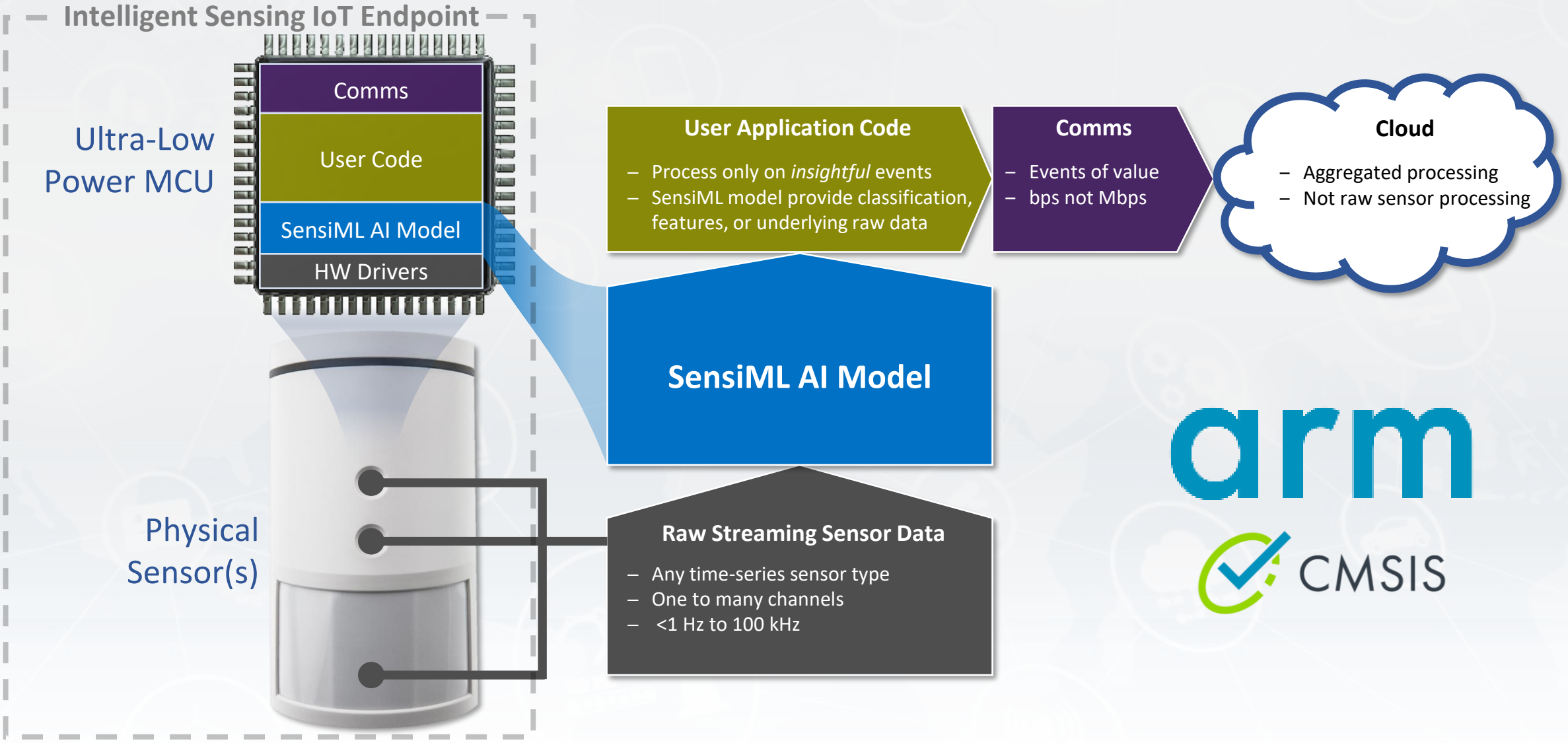
SensiML: Scalable AI for Intelligent IoT Sensing Applications



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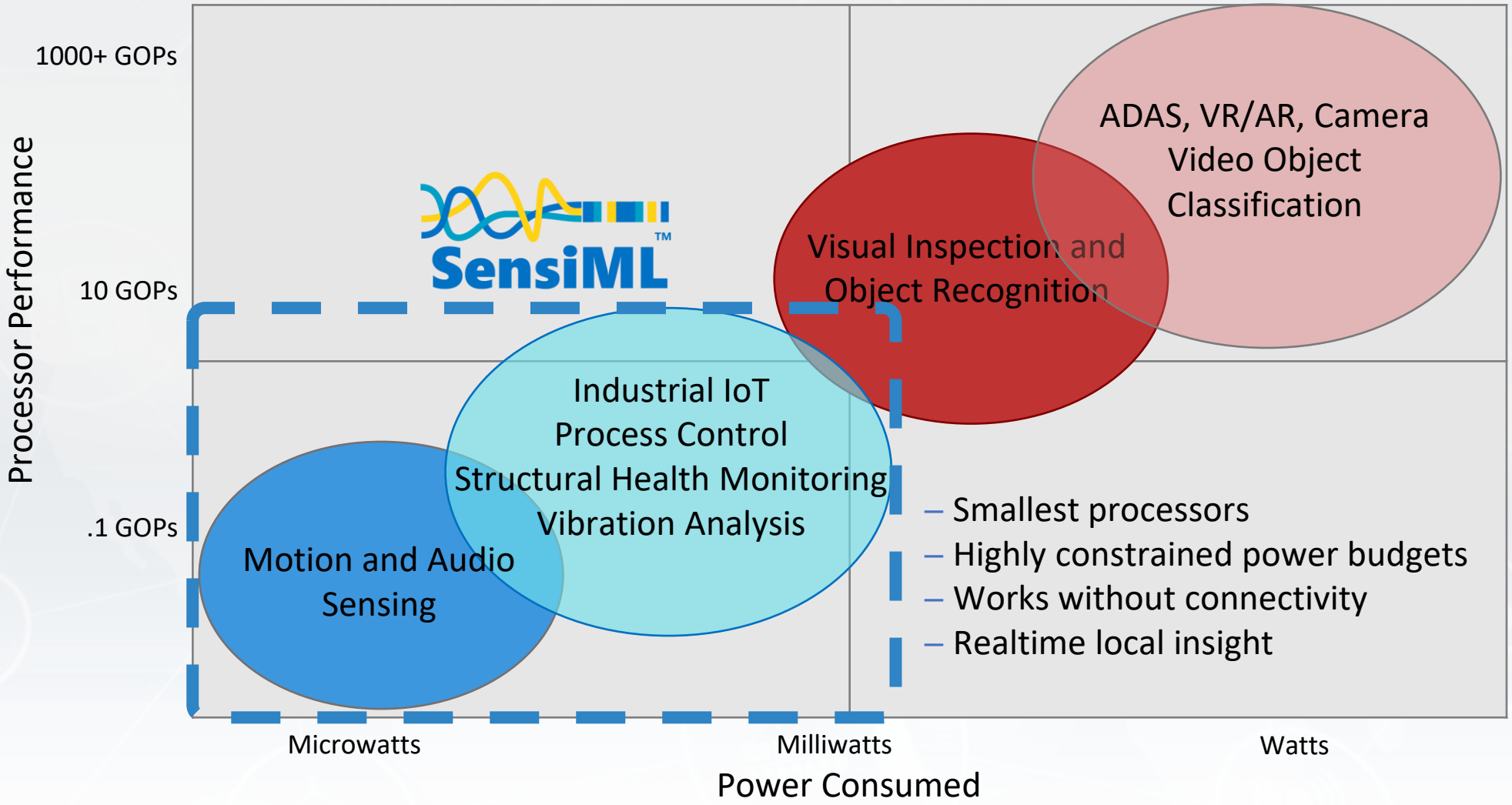
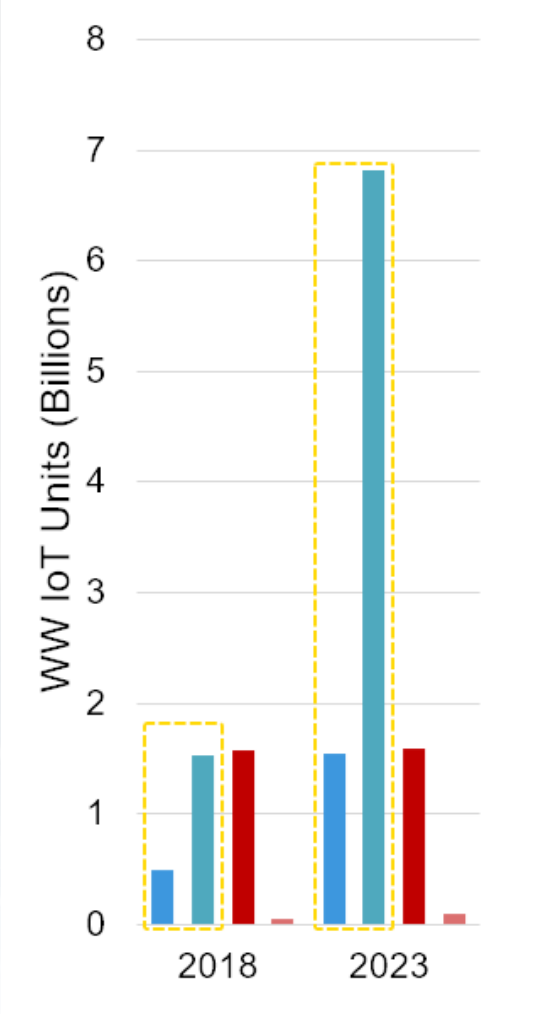
SensiML Addresses Billions of Time-Series IoT Endpoints





Source: IHS 2017

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Key Markets and Applications

Industrial

Predictive Maintenance

Anomaly Detection

Process Control & Inspection

Industrial Wearables

Consumer

Virtual Coaching Wearables

Smart Home and Consumer Goods Automation

Enhanced AR/VR Experiences

Commercial

Remote Predictive Maintenance

Smart City Infrastructure

Smart Building Lighting

Occupancy Detection

Healthcare

Eldercare / Aging in Place

Physical Therapy, Outpatient Rehab, and Sports Medicine

Healthcare Screening and Public Safety

Agriculture

Livestock Monitoring

Poultry Monitoring

Plant Health Monitoring

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How SensiML Accelerates Edge AI Creation

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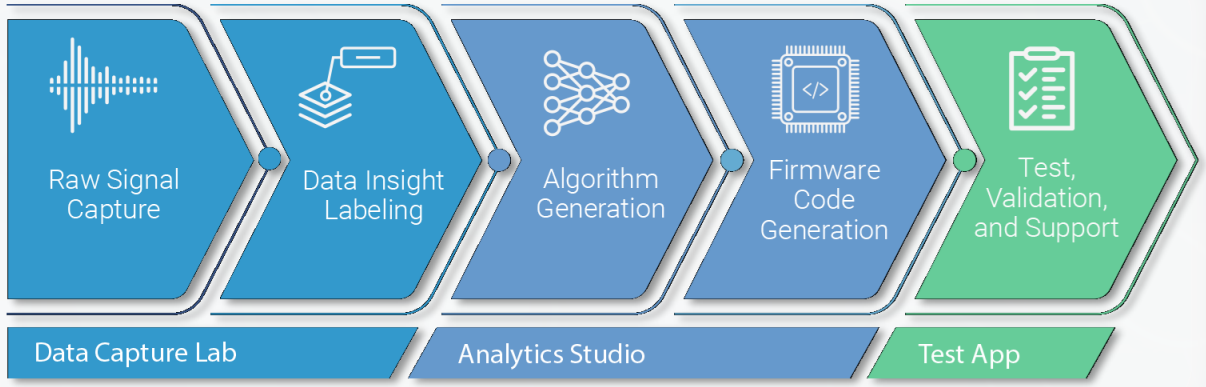
The SensiML Difference: Production Quality Tools for Real Products



- **Complete end-to-end AI workflow**
- **Comprehensive data collection & labeling**
- **Optimized Machine Learning Model**
- **Full code transparency and greatest flexibility**
- **Built from the ground-up for commercial development teams**
- **The most comprehensive partner ecosystem and global support network**

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The SensiML Workflow: Data-Driven Rapid Model Creation

Capture Data

SensiML Data Capture Lab

Time: **Hours to Weeks**
(Depending on application data collection complexity)

Skill: **Domain Expertise**
(As required to collect and label events of interest)

Build Model

SensiML Analytics Studio

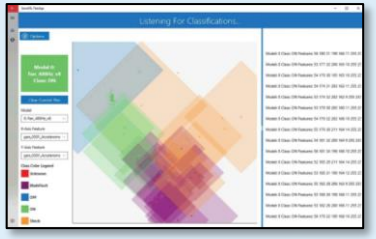
Time: **Minutes to Hours**
(Depending on degree of model control exerted)

Skill: **None**
(Full AutoML)

Basic ML Concepts
(Advanced UI tuning)

Python Programming
(Full pipeline control)

Test Device



SensiML TestApp

Time: **Minutes to Weeks**
(Depending on app code integration needs)

Skill: **None**
(Binary firmware with auto generated I/O wrapper code)

Embedding Programming
(Integration of SensiML library or C source with user code)

No Data Science or AI Expertise Required, Prototype Model Testing Without Coding

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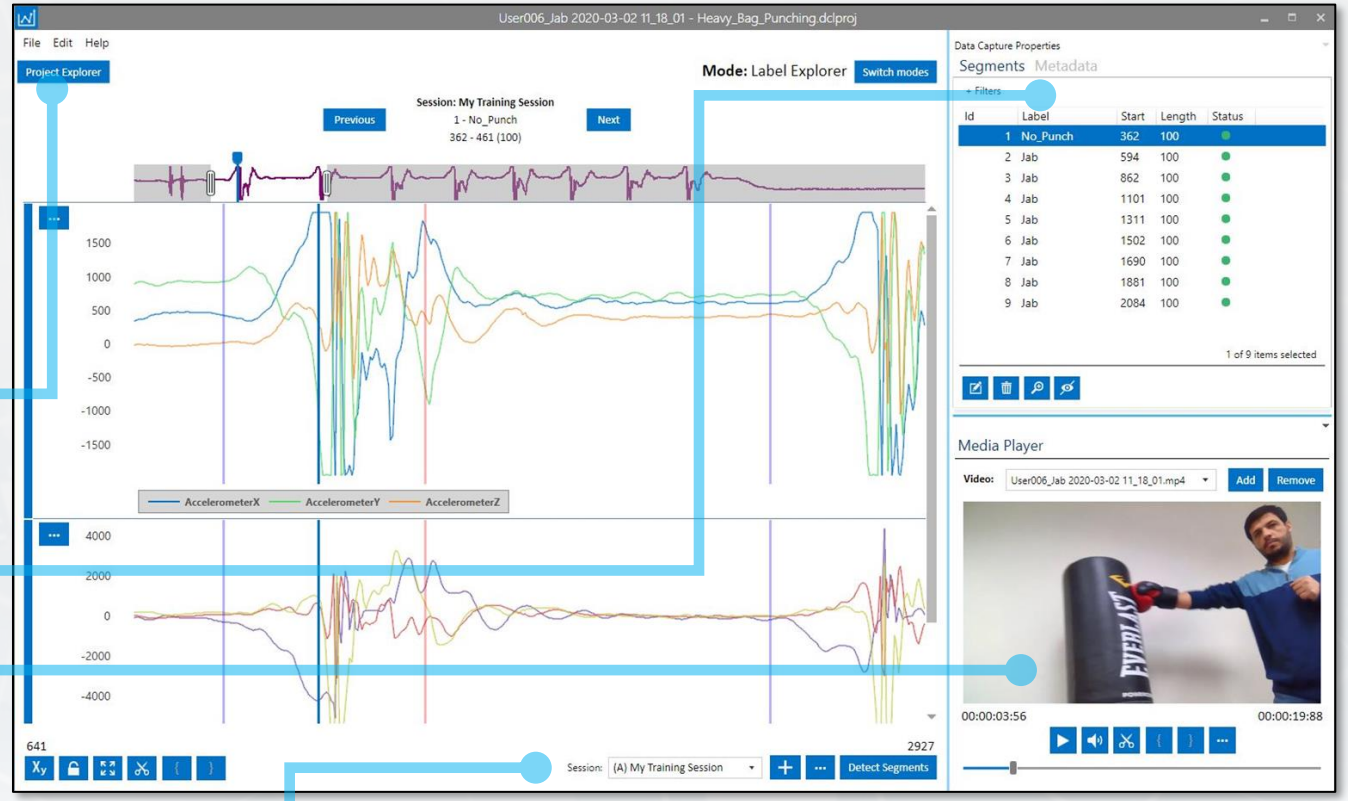
SensiML Data Capture Lab – Better Dataset Collection

- **Train/Test Data Collection**
- **Multi-User Project Collaboration**
- **Automated Data Management**
- **Data Labeling & Metadata Annotation**
- **Synchronized Video Annotation**
- **Auto Segmentation and Triggering**



SensiML Data Capture Lab

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SensiML Analytics Studio – Better Analysis & Modeling

- **Server Based AI Code Generation**
- **Classic ML to Neural Networks**
- **Automatic or Directed Model Creation**
- **Rich Data Visualization and Analysis**
- **Streamlined User Interface / Experience**

SensiML Analytics Studio

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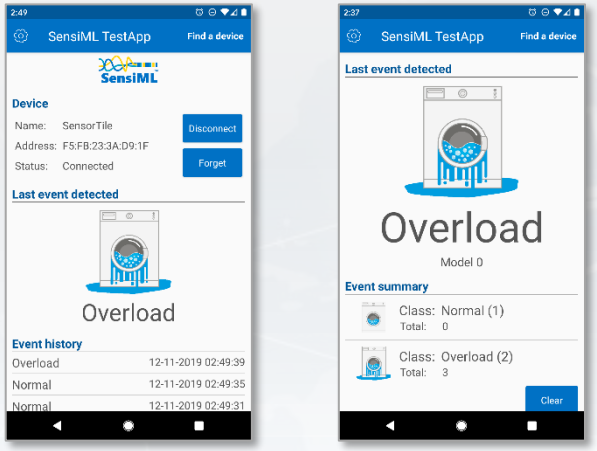
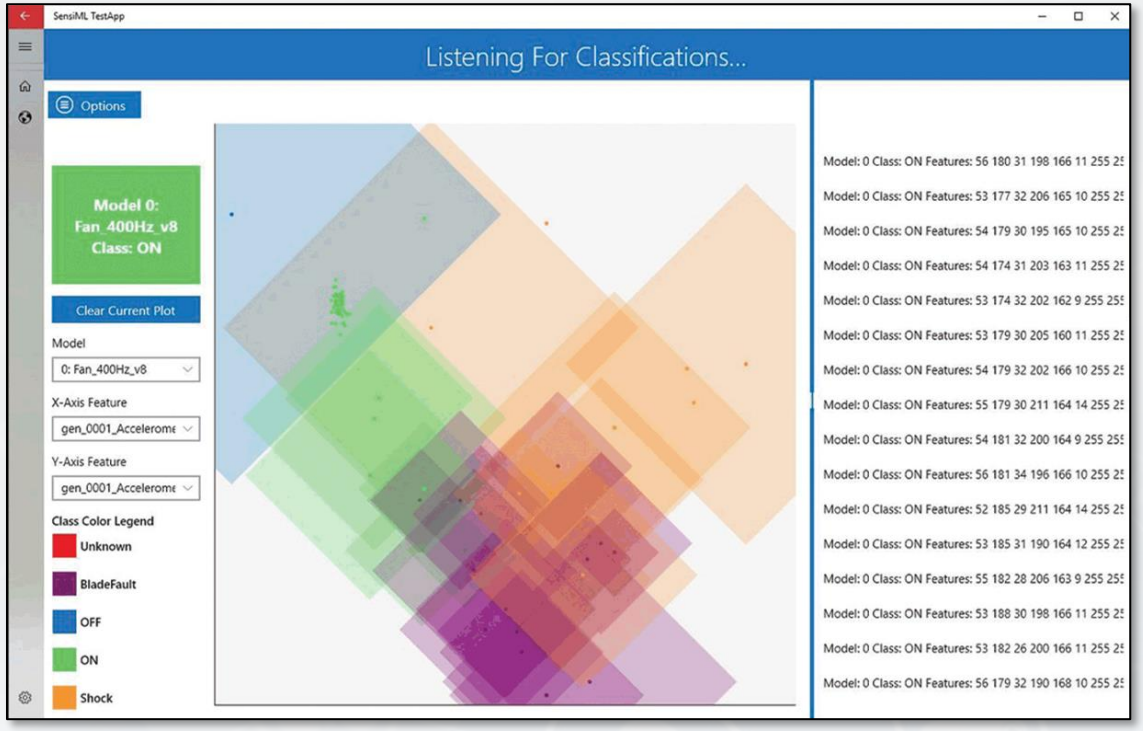
SensiML TestApp – Rapid On-Device Model Testing

- **Test Tool for Model Validation on Device**
- **Real-Time and Logged Collection**
- **Rich Visualizations and Debug Info**
- **Windows and Android versions**



SensiML TestApp (Android)



SensiML TestApp (Windows)

arm CMSIS

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Resulting IoT Endpoint Model: SensiML "Knowledge Pack"

Runtime On-Device Sensor Processing

Raw Sensor Data

- Time-series
- Digital or ADC sources
- <1Hz thru 1MHz
- 1 to many channels
- Mixed sensor types

Signal Pre-Processing

- Filtering
- Downsampling
- Averaging
- Vector Magnitude
- Scaling
- Normalization

Event Triggering

- Threshold
- Sliding window
- Peak Detect

Feature Transformation

- Fully automated selection
- Library of 80+ feature transforms
- Option for manual definition / tuning

Classification

- Classic ML (SVM, distance, trees)
- Hierarchical models
- Neural Network (TensorFlow Lite)
- Fully automated or manual tuning

Inference Result

- Ordinal class value
- Interim feature vector
- Associated raw data buffer

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Demo

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life.augmented

NXP

TensorFlow

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AVNET
Reach Further™

FUTURE ELECTRONICS

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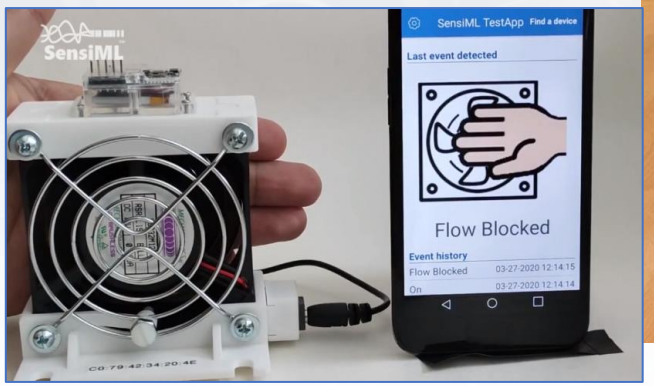
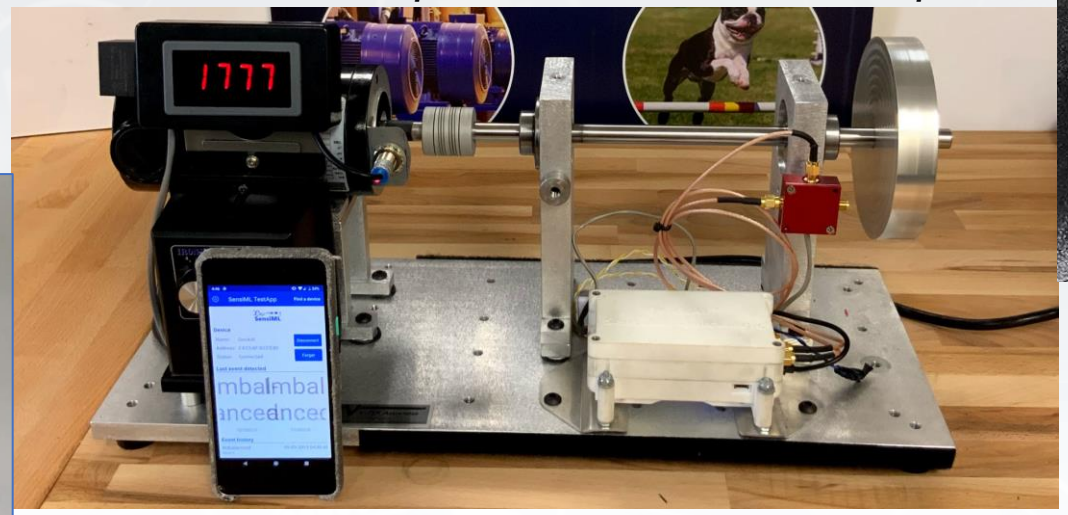
Predictive Maintenance and Anomaly Detection From Audio and Vibration

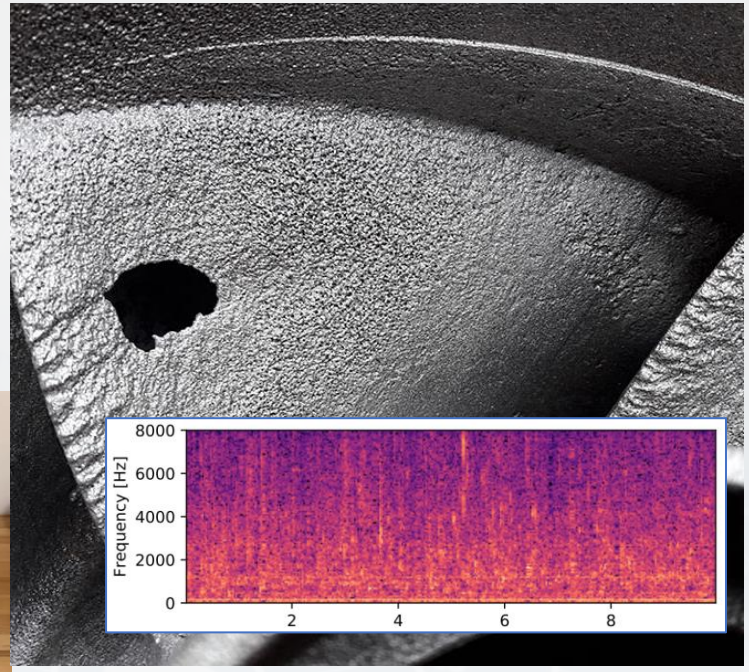
Skilled equipment operators are taught to detect and react to machine faults learned through years of experience. With SensiML AI algorithms, this same trained ear wisdom can be applied to 24/7 automated sensor endpoints.

- Slide rails and linear bearings
- Hydraulic / pneumatic valves
- Conveyors and belt/pulley
- Fan and blowers
- Custom equipment
- Custom processes



High sample rate vibration and microphone sensor stream inputs





Mining operation slurry pressure pump defect enlarged

Inset: Spectrogram of single pump audio sample

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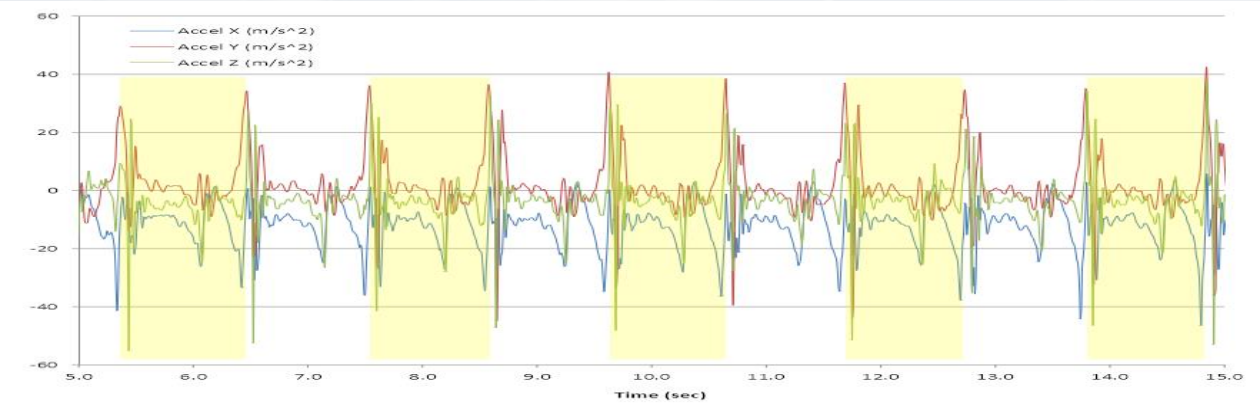
Virtual Coaching Wearable Using Real-Time Form and Gait Analysis

- End-to-end toolkit for creating real-time activity and form analysis on-device using SensiML sensor AI
- Gait analysis, form assessment, injury prevention and performance improvement from motion and acoustic, and biosensor classification
- Fully autonomous AI processing and insight, no cloud or smartphone needed
- Available, richly annotated, licensable datasets for selected applications including running, weightlifting, racket sports, and football



Treadmill running protocol gait measurement for single channel of twelve total 9DoF sensors captured in SensiML virtual running coach model

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Wellness Screening with Endpoint AI Time-Series Sensor Processing

Overview

Transform raw signal data from bio, acoustic, and environmental sensors to provide real-time inference and wellness classification using AutoML techniques.

SensiML Analytics Toolkit can rapidly construct classification models from multiple sensor inputs including:

- Core body temperature trending
- Optical PPG reflection-type pulse / HRM sensors
- VoC gas sensors
- Microphone / acoustic measurement
- Galvanic skin response
- Force / load cell (body weight) trending
- Motion from multi-axis IMU sensors

Proven SensiML Health/Wellness Applications

- Acoustic respiratory cough classification
- NFC temperature patch health classifier
- Wellness / fitness wristband wearables
- First responder status / health wearable
- Gait analysis / fall detection

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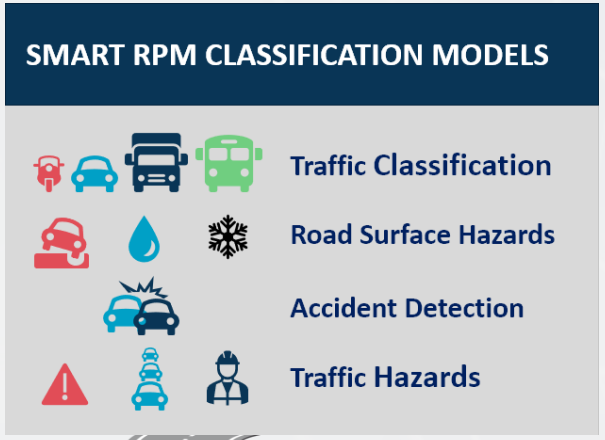
Smart Raised Pavement Markers Enable Safer Roadways

Overview

There are few items more pervasive than the ordinary raised pavement marker (RPM). Consider the possibilities when this simple passive safety device is transformed into a smart IoT active safety device with the following capabilities:

- Multi-axis vibration sensor
- Microphone
- Ultra low-power ML-capable microcontroller
- Adaptive high power RGB LED
- Wireless connectivity
- Solar charging and battery charging circuitry
- AI pattern recognition algorithm powered by SensiML



https://datadepot.sensiml.com/datasets/smart-road-sensor

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To Learn More…

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Attendees: don’t forget to fill out the survey to be in with a chance of winning an Arduino Nano 33 BLE board

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