시스템 시뮬레이션을 위한 인공지능과 모델기반설계의 통합
송완빈 과장
Di$Boss calling...
Two Projects

**Motor Diagnostic**

- Stator Winding Temp
- PM temp

**Lane and vehicle detection**

*Today’s Objective: How to Build AI Functionality into your Systems*
Learning Algorithms Driving the AI Megatrend
Learning Algorithms Driving the AI Megatrend

Statistics and Machine Learning Toolbox

- Oversteering Detection
  - BMW
- Predictive Maintenance
  - Baker Hughes
- Digital Twin
  - Atlas Copco
- Automatic Ground-Truth Labeling
  - Caterpillar

Deep Learning Toolbox

- Defect Detection
  - Airbus
- ECU Control
  - Denso
- Seismic Event Detection
  - Shell

Reinforcement Learning Toolbox

- Powertrain control
  - Vitesco Technologies
Increasing System Complexity

Model-Based Design and AI can help build complex systems

- System Requirements
- System Functionality and Architecture
- Subsystem Design
- Subsystem Implementation
- System Integration and Qualification
Increasing System Complexity

Model-Based Design and AI can help build complex systems

AI-driven system design workflow

Data Preparation
Modeling & Training
Simulation & Test
Deployment
Integrating AI Models into Simulink

**AI for algorithm development**
- Simulate for system-level testing
- Verify system requirements
- Deploy overall design to CPU, GPU, ECU, FPGA or a mix of targets

**AI for environment modeling**
- Speed up high-fidelity model
- Use data-driven model where mathematical modeling is challenging
- Share component with non-experts in a particular modeling domain or tool
Case Study 1

Why Machine Learning over traditional quantitative/qualitative methods?

- Higher accuracy
- Process may be challenging or impossible to model
Estimate Motor States with Machine Learning

E-Motor Diagnostics

Stator Winding Temp

PM Temperature

Pulse Width Modulation

PWM_disable
How to Integrate Machine Learning?

Built-in Machine Learning blocks

- Classification Ensembles
- Regression Ensembles
- Classification SVM
- Regression SVM
- Classification Trees
- Regression Trees

Example: SVM Classification block

MATLAB Function Blocks

- Preprocessing
- Feature Extraction
- Other models
Case Study 2

Why Deep Learning over traditional Computer Vision?

- No feature engineering
- Higher accuracy
Highway Lane Following Model

3D Scenario & Visualization

Sensor Fusion

AI model

Vision Detector

Lane Following Controller

Vehicle Dynamics

Metrics

Decision Logic & Controller
Deep Learning Networks in MATLAB/Simulink

**Image Classification, Semantic Segmentation**
- ResNet
- Inception v3
- MobileNet v2
- GoogLeNet
- VGG

**Object Detectors**
- YOLO v2
- SSD

**Sequence Networks**
- LSTM
- BiLSTM

**MATLAB Function Diagrams**
- IMAGE CLASSIFIER
- PREDICT
- STATEFUL CLASSIFY
- STATEFUL PREDICT
GPU Simulation
Run on Jetson AGX Xavier

- Pre-processing
- Lane Detection
- Vehicle Detection
- AlexNet-based Post-processing
- YOLO v2
Run on Jetson AGX Xavier
Run on CPUs

- Pre-processing
- Lane Detection
- Vehicle Detection
- Post-processing
- AlexNet-based
- YOLO v2

ARM CPU
Generic CPU
Import Trained Models
External Deep Learning Framework Support

TensorFlow Importer

ONNX

TensorFlow
Caffe2
PyTorch
mxnet

Chainer
Microsoft Cognitive Toolkit
“A model-based development workflow is essential in order to use AI for control ECUs. Combining the existing control model and the AI model enables us to establish a simulation environment and accelerate product development.”

- Natsuki Yokoyama, Denso Ten

www.matlabexpo.com
Additional AI Examples

Data Preparation  Modeling & Training  Simulation & Test  Deployment

Human Activity Recognition

Fault Identification

Battery State of Charge Estimation

- Human Activity Recognition
- Fault Identification
- Battery State of Charge Estimation
Key Takeaways

Integrate trained AI models into Simulink

- Test design in simulation
- Code generation
- Integrate AI models from others
감사합니다