Name	Job Title	Area of Expertise
MARUTA Hidenori	Associate Professor	Industrial Electronics

1. Main Research Topics

① Edge-Shallow Neural Network Control of DC-DC converter

DC-DC converter has an essential role in a wide range of electronic devices. With the rise of IoT devices, DC-DC converter is required not only to provide a stable power supply but also to provide a superior function for complex control to meet various demands.

Recent advancements in microcomputers have made it possible to perform complex signal processing and control at the very edge of IoT networks. This enables to form edge computing, where tasks that were previously impossible can now be carried out in edge-level computing resources. Our research is developing a new control method that leverages these advancements. We investigate the use of neural network, a most popular and practical type of AI, for such purposes. The training part that requires a large amount of computing resource and processing power is handled by powerful cloud resources via a network connection. Meanwhile, the inference or prediction part, which is the faster and requires less intensive computation burden is done directly on the edge device. This approach allows us to achieve superior levels of stability and fast response. The system can also adapt to changing conditions and external disturbances through its learning capabilities.

② MPC and AI for Design and Control of DC-DC Converter

Model based designing and controlling of complex systems requires models of individual systems and integrating them into one complete model. However, even if individual models are accurate, the precision of the overall model can decrease due to inconsistencies caused by connections or the propagation of disturbances throughout the system. Furthermore, in real operation, there is model uncertainty due to factors like component-level tolerances.

This research combines Model Predictive Control (MPC) with system identification to correct model inaccuracies. It is realized by using the prediction of the model and observed data to adjust discrepancies in the parameters in the model. Since a perfect or ideal model is impossible to obtain, the system is treated as a black box to a certain extent. We are currently developing specific methods that use AI techniques for estimation to improve the system's performance.

③ Methodology of Anomaly Detection and Fault Diagnosis for Industry

Detecting anomalies or faults from data is a difficult task for computers, while often easy for humans. This is because to give a quantitative definition of “anomaly” is challenging; which humans often rely on experience and intuition. In such cases, standard AI methods frequently fail to achieve high accuracy.

This research explores methods for detecting abnormal states, such as anomalies and faults, directly from data. Our specific examples are:

- Detecting smoke or fire from video data (surveillance footage).
- Detecting faults in a DC-DC converter from its observed values.

By combining model-based and AI-based approaches, we aim to develop a method that reflects the unique characteristics of the systems and to provide a superior function for several specific purposes.

2. Keywords

Power conversion, Model based method, AI, Anomaly, Fault detection

3. Remarks and Websites

researchmap： https://researchmap.jp/h_maruta
Laboratory: https://sites.google.com/view/maruta-lab/