Practical Reinforcement Learning Design Methods for Home Appliances

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Abstract:

Among machine learning, reinforcement learning (RL) has the excellent feature of autonomously acquiring controlling rules to maximize cumulative rewards. RL is expected to be a technology for building a truly autonomous system. It is no exaggeration to say that RL is one of the essential technologies for realizing a society based on advanced science and technology, such as Society 5.0 proposed in Japan and Industry 4.0 proposed in Germany.

However, the practical application of RL cannot give so many cases as compared with supervised learning represented by image recognition. This is because RL requires a large amount of data and trial and error, while there are only a limited number of systems that make this possible.

Developers for applying RL into the systems with limited trials suffer from the facts that "the design method that meets the system requirements is not known" and/or "the method of reflecting domain knowledge in the design to meet the system requirements is not known." In the past, the design of RL was realized by trial and error by simulation, or depended on each individual's design Know-How. In other words, these design issues are not discussed in detail through multiple applications.

Therefore, this paper proposes practical design methods to resolve these design issues and meet the system requirements with limited data and computer resources through the RL design for three home appliances: washing machines, refrigerators, and domestic hot-water systems. Specifically, the proposed methods and training techniques achieved noise and vibration reduction of the washing machine with the actual product. In addition, RL designs were proposed for refrigerators and domestic hot-water systems to reduce electricity costs in demand response using Modelica Simulation.

The proposed methods can design scalable and practical RL systems with domain knowledge and promote the practical implementation of RL in society.