Artificial Intelligence and its Reasonable Application Scenario to Reactor Operation

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1. Introduction

Various ICT (Information and Communication Technology) now live together tightly with us since the beginning of the smartphone era which is triggered by Apple coming with iPhone. These technologies move with us, recognize our status, transmit this information if required, do some appropriate analysis on it, and provide us with useful feedback.

Last year, we all have watched a ground-breaking go game that has players from two different races, a top tier human go player vs. a machine. The name of the machine player was 'AlphaGo' and the AI (Artificial Intelligence) inside it has been developed by Google DeepMind [1,2]. Most of the people who watched the game have been shocked by the result of the game. The current state of AI technology was way beyond our prediction. It was one of the most meaningful debut of AI.

Now the AI technology influences all the areas in industry, academia, and even art, and makes noticeable changes in their future map. The analysis and prediction on this phenomenon is still undergoing. Research topics on the reactor and its control haven't include these kinds of state-of-the-art technologies because they generally requires high safety level. However, the difference in technology readiness or the maturity level compared to other areas will be getting larger if we are not trying to adopt those technologies for the researches on the reactor.

This paper presents brief but reasonable scenarios for applying AI or machine learning technologies to research reactor from various perspectives.

2. AI Application Scenarios

Before stepping into AI application scenarios, we need to see the reactor system itself and other facilities or systems around it as operation targets that need to be automated, including a possible way to reduce human errors while operation. Since most of the researches on research reactor are safety critical, it would be reasonable to take less safety critical scenarios into consideration first. Following scenarios show possible application of AI to the research reactor technology.

2.1 AI Assistant

The power of up-to-date AI systems are basically based on its ability to learn from new data set and adapt itself not only for the previous and conventional environment but also for the current environment that has some differential changes. In this regard, an AI system in beginning phase would start learning with initial operation data that is generated by skillful senior operators. This data is right operation profile with high probability. As more and more data is learned, the probability of the AI assistant's ability to generate right operation will increase. Thus we can wait until the AI assistant will reach predefined admissible reliability threshold. Moreover, multiple AI assistants could be implemented in such a way that each of which is trained using different set of data. In this case, multiple assistants can be used to make more reliable and consistent decision through a voting procedure. Figure 1 shows a brief diagram of multiple assistants, where AIA (AI Assistant) and HO (Human Operator).

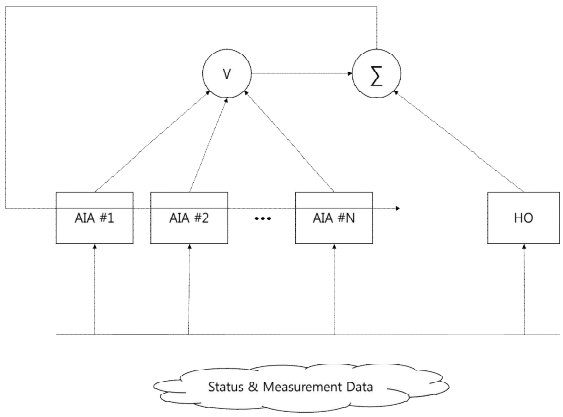

Fig. 1. Configuration diagram for multiple AI assistants

2.2 1-to-1 tutor for new operator candidates

Once the AI assistant is trained enough to generate desirable operation profile with high probability, it can also be used to train human operators who don't have enough experience to make right decision. This means operation training for unexperienced human operator can be performed by an automated framework that is implemented with AI assistants. It can actually replace the senior operators in the education and training of junior operators.

This method will dramatically reduce the cost for training newly assigned human operators. And it also has a benefit of consistent training even if there are abnormal changes or discontinuity of operator members.

The AI assistant itself will be a cumulative archive of the operation skills and knowledge.

Figure 2 shows a training framework using AI assistants in section 2.1.

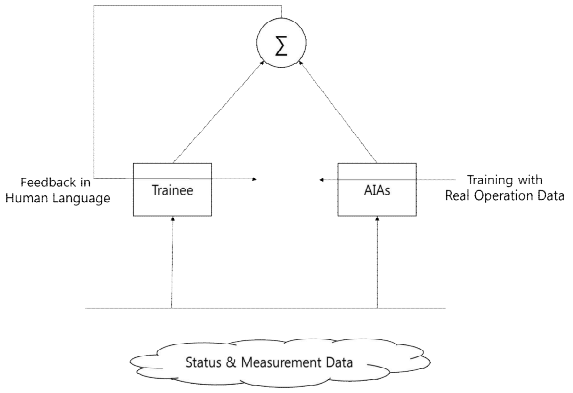

Fig. 2. Diagram of training framework using AI assistants

The specific examples of this application could include

- Decision making for emergency situation
- Fan control for cooling systems
- Training of junior operators on above cases

3. Conclusion

Two less safety critical scenarios for applying AI to reactor operation are introduced in this study. However, the AI assistant will not only be an assistant but it will also be an operator in the future. What is required is big operation data which can represent all the cases requiring operation decision, including normal operation and accident data as well, and enough time to train and fix the AI system with this data. We can predict AI study in this area can begin with a mild and safe application. But in the near future, this technology could be used to handle or automate more severe operations.

ACKNOWLEDGEMENT

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