**(A Parallel Processing Scheme on TensorFlow for**

**Improving Training and Validation Performance)**

***Abstract*** Most deep learning systems spend lot of time on model training and validation. However, they sometimes tend to waste GPU and CPU resources because the pre-processing and batch processes based on a single thread result in a wait time. In this paper, we propose a new scheme that efficiently handles training and validation processes based on multi-threads. The proposed scheme can overlap the training and validation processes as much as possible by using a model copy operation that extends the processes with multi-threads. As a result, it improves the overall utilization of CPU and GPU. For evaluation, we implemented a convolutional neural network (CNN) using the TensorFlow framework. As a result, we clearly confirm that the proposed scheme saves the total training and validation time by up to 22.4% compared with the traditional schemes.

**Keywords: Multi-threads, deep learning, TensorFlow, GPU and CPU utilization**

Fig. 1 GPU utilization of the tf.data-based model

Fig. 2 Comparison of processes between the base pipeline and proposed pipeline

Fig. 3 Validation process of the proposed scheme

Fig. 4 Comparison of training performance using the MNIST dataset

Fig. 5 Comparison of training performance using the 1GB MNIST dataset

Fig. 6 Comparison of MNIST GPU utilization using the single thread pipeline

Fig. 7 Comparison of MNIST CPU utilization using a single thread

Fig. 8 Comparison of MNIST GPU utilization using the multi-thread pipeline

Fig. 9 MNIST Comparison of MNIST CPU utilization using the multi-thread pipeline

Fig. 10 Comparison of 1GB MNIST GPU utilization using the single thread pipeline

Fig. 11 1GB Comparison of 1GB MNIST CPU utilization using the single thread pipeline

Fig. 12 Comparison of 1GB MNIST GPU utilization using the multi-thread pipeline

Fig. 13 Comparison of 1GB MNIST CPU utilization using the multi-thread pipeline

Fig. 14 The ratio of model copy overhead to epoch training time.