Incremental Object Recognition using Hybrid Learning with Short-Term and Long-Term Memory

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***Abstract*—We propose a novel model for object recognition which introduces the concepts of short-term memory (STM) and longterm memory (LTM). Catastrophic forgetting is a critical problem in many incremental learning algorithms and is deeply related with the plasticity-stability dilemma [1]. To alleviate the degradation of the performance, we adapt one of the classical psychological models about human memory known as Atkinson-Shiffrin memory model [2]. In our model, we construct two separate memory models which have different characteristics and cooperate with each other. Short-term memory model learns the information with plasticity and keeps them during a short period and long-term memory stores the learnt information stably for a long time. Incremental $(2D)^2$ PCA (I $(2D)^2$ PCA) [3] is used in the STM to adapt the new data incrementally while standard batchtype $(2D)^2$ PCA is used in the LTM. Also, classifiers of the two memories have different learning approaches. While short-term memory uses generative classifier, long-term memory uses discriminative classifiers. Generative models are relatively flexible since they can easily construct or update models and are adequate for incremental learning. And discriminative models use the observed data and target variables of both positive and negative class to build the discriminating boundaries. It is useful to distinguish similar classes robustly. In the proposed model, Gaussian Mixture Models (GMM) are used for the STM and one class support vector machines (OCSVM) and two-class support vector machines (SVM) are used for the LTM as fast recall classifier and robust recall classifier respectively. And these two memories share their learnt information through rehearsal process and experience transfer. The rehearsal process provides rehearsed data which is usually not available in incremental learning algorithms. By adapting generative approach in the STM, distributions of learned data could be modeled directly and this information is used to recall previously learnt data. These rehearsed data is very useful for incremental learning of discriminative approaches since discriminative learning methods require data of the negative class to compare with positive class data. By using rehearsed data in learning of the discriminative model of the LTM, the LTM could learn new data without catastrophic forgetting or storing all previous data. Furthermore, since rehearsed data are blurred and perturbed a little, they give more robustness to the model [4]. And experience transfer provides well-tuned feature extractors of the LTM to the STM and this procedure could help the fast learning of the STM. Experimental results show the effectiveness on the object recognition system using hybrid learning of the proposed model.**

***Index Terms*—human memory model; short-term memory; longterm memory; rehearsal; experience transfer**

ACKNOWLEDGMENT

This research was supported by the Converging Research Center Program funded by the Ministry of Education, Science and Technology of Korea (2011K000659).

REFERENCES

[1] S. Grossberg, "Nonlinear neural networks: Principles, mechanisms, and architectures," Neural Networks, vol. 1(1), pp. 17-61, 1988.
[2] R. C. Atkinson, & R. M. Shiffrin, "Human memory: A proposed system and its control processes psychology of learning and motivation," Academic Press, vol. 2, 1968, pp. 89-195.
[3] C. Yonghwa, T. Tokumoto, L. Minho, & S. Ozawa, "Incremental twodimensional two-directional principal component analysis ($I(2D)^2$ PCA) for face recognition," IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), May 2011.
[4] F. Kunihiko, "Neocognitron trained with winner-kill-loser rule," Neural Networks, vol. 23(7), pp. 926-938, 2010.