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Introductory Article: Theory and Applications of Machine Learning (Ozeki Lab.)

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Abstract: We introduce our research activities in the theory and applications of machine learning and AI such as computer vision, Game AI, and natural language processing.

Keywords: Machine Learning, AI, Computer Vision, Game AI, NLP, Civil Engineering

1. Introduction

Our laboratory is currently vibrant with 21 undergraduate students and 10 graduate students, including one JICA student from Libya, two from China, one from Korea, and one from Malaysia, all of whom are full of individuality (Fig. 1). Our laboratory conducts theoretical and applied research on machine learning and AI. Our research topics are basically open-ended and range from computer vision, game AI, natural language processing, and more. In this paper, we present our research over the past two years.

2. Research Results

2.1. Jewelry image correction

Jewelry is a product whose value is linked to its visual appearance. Therefore, jewelry retailers use photo retouching software to manually process jewelry images to eliminate the difference between the actual appearance and the image captured by a camera for online transactions. Applying image-to-image translation techniques to jewelry images is challenging due to the shape of the jewelry, its color, blurring of the boundary between the jewelry and background, and the unique light reflections. We have proposed an image-to-image translation method that corrects a captured jewelry image to an expertly retouched image [1,16,17]. Our method [1] outperformed other methods as shown in Fig. 2.

2.2. Application to Civil Engineering

Automation of impact-echo monitoring, one of the non-destructive inspection methods for concrete structures, has been studied. For automation, it is necessary to perform machine learning based on labeled data prepared in advance, and only prediction should be performed on the test site using the pretrained model. However, the accuracy of defect discrimination generally decreases when data is collected at different locations. We applied data augmentation to anomaly detection methods based on convolutional neural networks (CNN) and Mahalanobis distance to obtain "true" generalization capability [4,10,12,14,15,18].

Fig.1 Lab members

Fig.2 Jewelry image correction: From left, original, ground-truth, CycleGAN, Ours

2.3. Game AI

Reinforcement learning is a type of machine learning that is useful for problems such as robot AI and game AI where it is difficult to give the correct action for a given situation. In our lab, we study applications of deep reinforcement learning to robot simulation [5] and car racing AI [6] (Fig.3). We are also working on rival Shogi AI for human learning [8,13] and video game analysis [9].

2.4. Natural Language Processing

VAD models that analyze emotions in three dimensions has been proposed to capture complex human emotions more precisely. We propose an efficient structure for a transformer model that recognizes VADs using the EMOBank dataset and the pre-trained large-scale language model, RoBERTa [7]. Furthermore, a dialogue system is being developed to assist first-year university students.

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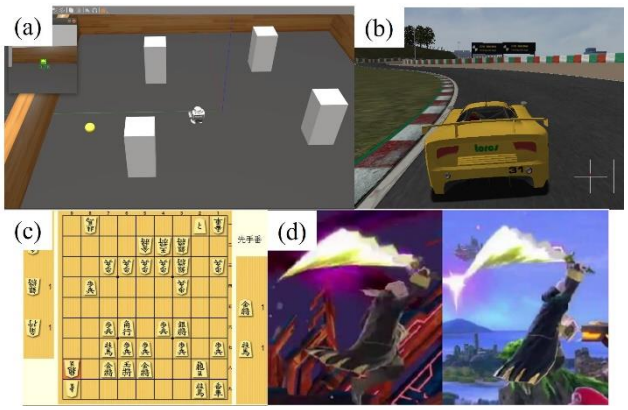

Fig.3 Game AI: (a) Robot AI navigation (b) Car racing AI (c) Rival Shogi AI (d) Game video analysis

3. Conclusion

In addition to the above research topics, students also conduct theoretical research on self-supervised learning [2,11], Brain Computer Interface [3], hand gesture recognition [19] and video classification. Since the research themes are dispersed, there are many difficulties. However, students actively participate in academic conferences and international conferences because students themselves work hard in a free atmosphere.

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