Usage Report for Fiscal Year 2022

**Project Title:**
**Development of human visual system-inspired image processing system**

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1. Background and purpose of the project, relationship of the project with other projects

Image compression is important due to the increasing use of large-scale and high-resolution images as well as applications with limited communication bandwidth (e.g., telepresence systems and wireless sensor networks). However, most of the previous research compressed the original images directly without any scene understanding process. In our project, we are currently developing image compression technologies that apply these visual characteristics, with the goal of enabling real-time video communication between remote operation robots and aircraft and space environments through telepresence systems.

2. Specific usage status of the system and calculation method

Our encoding stage firstly uses deep learning to predict the saliency map for a input image. Then, the saliency and gradient maps are mixed to calculate the importance map. Critical pixels such as image encoding sites were adaptively sampled by importance map-based error diffusion method. Our decoding stage consists of binary decoding and image reconstruction from the sampled color pixels. We are currently using tensor completion methods with HOKUSAI system for the image reconstruction processing.

3. Result

For the image reconstruction part, we compared the results from four different completion methods in HOKUSAI system: (1) simultaneous tensor decomposition and completion; (2) high accuracy low-rank tensor completion; (3) Bayesian CP factorization; (4) manifold modeling in embedded space; We are currently calculating two image quality assessment metrics: peak signal-to-noise ratio and structural similarity for the evolution of image quality.

4. Conclusion

We have proposed an image compression framework based on an aspect of human visual importance. Our new framework efficiently encodes an input image, while preserving its visual features by sampling color pixels adaptively from the estimated importance map, which is suitable for the prior information-based models in our decoding process. Our numerical experiments demonstrated that the proposed framework incorporates visual attention and geometric features well into the compression process as compared with conventional sampling methods.

5. Schedule and prospect for the future

Based on the current results, we plan to use generative neural network for the image reconstruction. Moreover, applications to retinal model simulations and other image processing tasks via our vision-inspired importance maps hold future promise.