電機資訊學院 2024 作 BRAIN PLUS HAND 實作專題競賽

Human-Machine Co-Creation: Generating Imaginative Paintings from EEG Brain Activity

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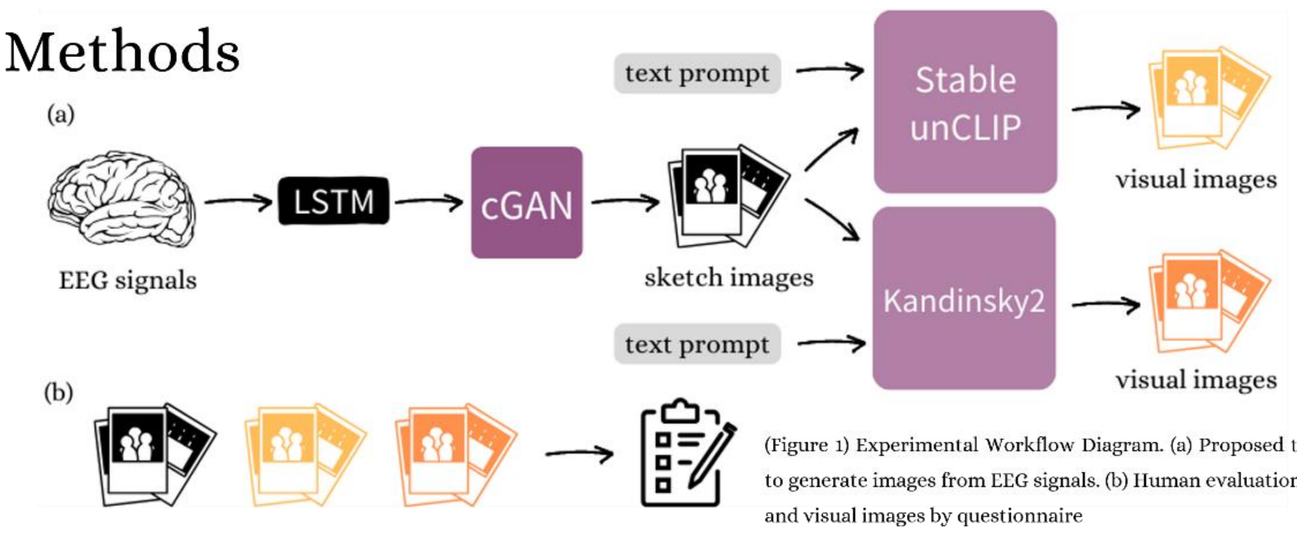
Introduction

In the past two years, generative artificial intelligence has rapidly advanced. In addition to natural language processing, there have been significant breakthroughs in image resolution and aesthetics. This leads one to ponder whether artists can collaborate with generative AI in the future. Perhaps, by merely sketching a composition in one's mind, it could be transformed into reality through the use of artificial intelligence. Therefore, this project offered an alternative path for converting EEG signals into images, capable of generating higher quality and more realistic artistic images. This represents a visible advancement in bringing one's imaginative visuals to life and has the potential to greatly enhance creativity in the field of art.

Methods



(Figure 1) Experimental Workflow Diagram. (a) Proposed two-stage method to generate images from EEG signals. (b) Human evaluation of sketch images and visual images by questionnaire

In this project, the EEG2Image model architecture [1] was employed. It involved extracting EEG signal features using an LSTM classifier and then retraining the model with the extracted EEG signals along with noise in a cGAN model. The cGAN generated sketches, which, along with images from the original test dataset, are input into Stable unCLIP [2] and Kandinsky2 Image-to-Image with ControlNet [3] respectively. Finally, the results of the generated images are analyzed through a questionnaire survey.

Results

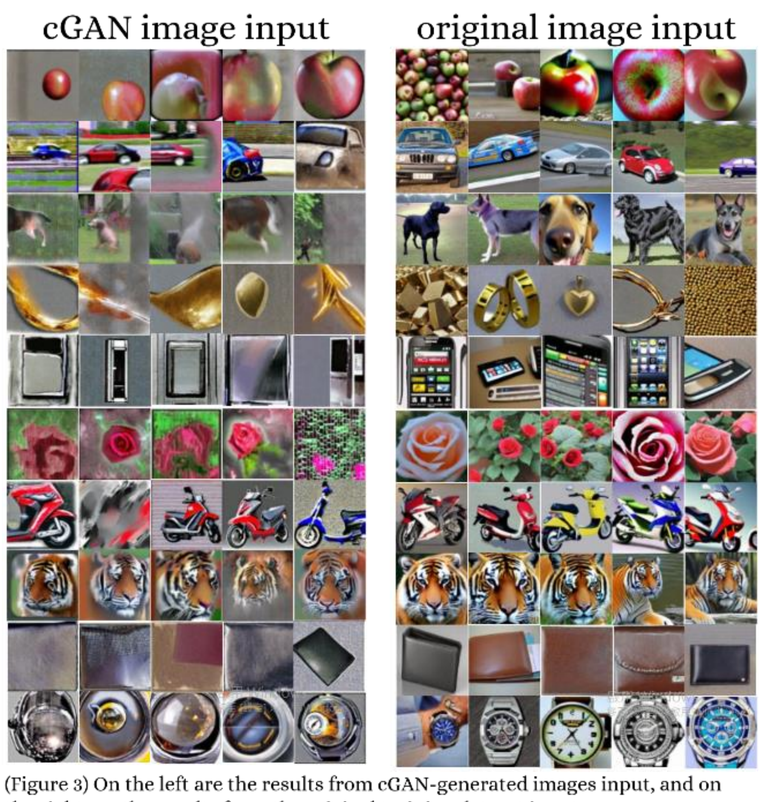
cGAN sketches

Overall, the images generated after retraining exhibit better performance compared to the results reported in the original literature.

(Figure 2) On the left are the results from EEG2Image, and on the right are the results after retraining.

Stable unCLIP

The quality of the results heavily depended on the completeness and clarity of the input images which may lead to more comprehensive generated outcomes.

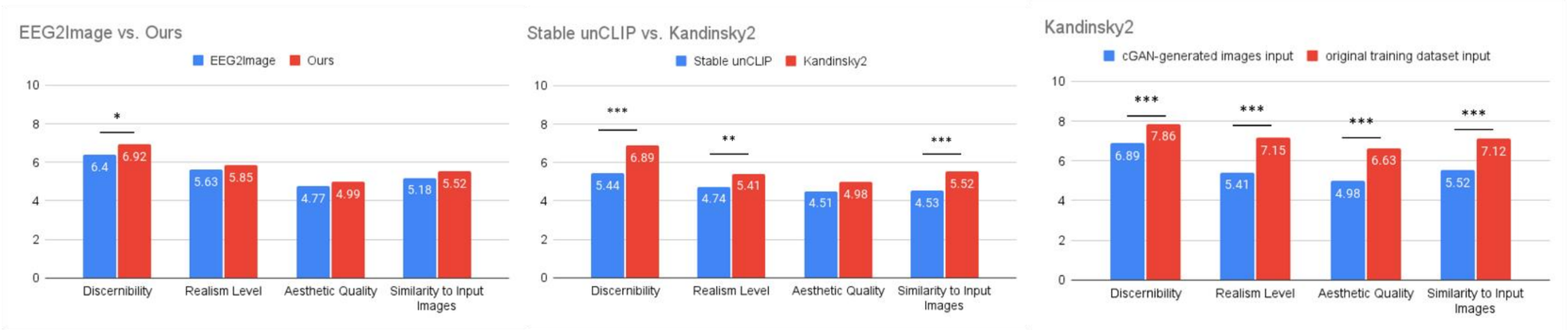


(Figure 3) On the left are the results from cGAN-generated images input, and on the right are the results from the original training dataset input.

Kandinsky2

It placed greater emphasis on textual prompts. Even if the input images are blurry, the model can still generate meaningful and aesthetically pleasing images.

(Figure 4) On the left are the results from cGAN-generated images input, and on the right are the results from the original training dataset input.



(Figure 5) From left to right, these are the results of the evaluation through a total of 104 questionnaires for Figures 2 to 4. In addition to reaffirming the conclusions drawn from the previous experiments, it is also evident that the cGAN-generated images input into Kandinsky2 exhibit a high level of aesthetics, lower similarity to the input images and realism level, and tend to have a certain level of discernibility. This indicates the ability of this system to generate images that are both aesthetically pleasing and imaginative. (*:P < 0.05, **:P < 0.01, ***: P < 0.001)

In conclusion, the image input generated from EEG features in the image-to-image generation model can create imaginative images with a higher degree of artistic quality and a certain level of recognizability.

[1] P. Singh, P. Pandey, K. Miyapuram, S. Raman. EEG2IMAGE: Image Reconstruction from EEG Brain Signals. arXiv:2302.10121. 18 Mar 2023. https://doi.org/10.48550/arXiv.2302.10121
[2] https://huggingface.co/docs/diffusers/main/en/api/pipelines/stable_unclip
[3] Arseniy Shakhmatov, Anton Razzhigaev, Aleksandr Nikolich, Vladimir Arkhipkin, Igor Pavlov, Andrey Kuznetsov, and Denis Dimitrov. Kandinsky 2. 2022. https://github.com/ai-forever/Kandinsky-2