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Reconstruction of Visual Stimuli Using Stable Diffusion with Text Conditioning

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Abstract : The human brain, among the most complex and mysterious aspects of the body, harbors vast potential for extensive exploration. Unraveling these enigmas, especially within neural perception and cognition, delves into the realm of neural decoding. Harnessing advancements in generative AI, particularly in Visual Computing, seeks to elucidate how the brain comprehends visual stimuli observed by humans. The paper endeavors to reconstruct human-perceived visual stimuli using Functional Magnetic Resonance Imaging (fMRI). This fMRI data is then processed through pre-trained deep-learning models to recreate the stimuli. Introducing a new architecture named LatentNeuroNet, the aim is to achieve the utmost semantic fidelity in stimuli reconstruction. The approach employs a Latent Diffusion Model (LDM) - Stable Diffusion v1.5, emphasizing semantic accuracy and generating superior quality outputs. This addresses the limitations of prior methods, such as GANs, known for poor semantic performance and inherent instability. Text conditioning within the LDM's denoising process is handled by extracting text from the brain's ventral visual cortex region. This extracted text undergoes processing through a Bootstrapping Language-Image Pre-training (BLIP) encoder before it is injected into the denoising process. In conclusion, a successful architecture is developed that reconstructs the visual stimuli perceived and finally, this research provides us with enough evidence to identify the most influential regions of the brain responsible for cognition and perception.

Keywords : BLIP, fMRI, latent diffusion model, neural perception.
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