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# AN APPROACH TO IMAGE ENHANCEMENT OF MARINE UNMANNED PLATFORMS WITH SEGMENTED AUTOENCODERS

**Abstract:** This study provides an image enhancement method based on a segmented autoencoder for marine unmanned platforms. It optimally compresses and reconstructs data using an encoder on the vehicle and a decoder on the base, providing efficient real-time visualization in challenging marine environments.

**Keywords:** Marine unmanned platforms, U-Net architecture, SAM, autoencoder, JANUS standard.

In the dynamic field of maritime technology, unmanned platforms are attracting considerable interest due to their potential to revolutionize seabed exploration and maritime operations. These platforms, which include autonomous surface vehicles, autonomous underwater vehicles, and remotely operated vehicles, play a key role in a variety of tasks, from data collection to environmental monitoring and rescue operations. Still, these platforms face challenges in data transmission and image quality due to limited computing resources and harsh marine environments [1].

The main goal is to develop a solution that will improve data transmission efficiency, processing capabilities, and image quality. Central to this framework is a complex model of an auto-encoder consisting of an encoder placed on an offshore unmanned platform and a decoder at a base station. The model's performance is based on its initial training, which includes a comprehensive sea surface image dataset representing a wide range of real-world marine conditions. The goal of this training phase is to optimize the model by minimizing a loss function, which effectively reduces the differences between the input and output images.

After training, the encoder is integrated into the marine unmanned vehicle. Its main function is to convert high-dimensional input images into a compressed format in a low-dimensional latent space, thus optimizing the data for transmission. This compressed data is then transmitted wirelessly to the base station, where a decoder reconstructs and improves the image quality using sophisticated algorithms [2].

The choice of U-Net architecture in this methodology deserves special attention. Originally developed for biomedical image segmentation, its effectiveness in handling image nuances makes it an ideal option for this application. The split-path architecture, which includes a narrowing encoder and a widening decoder, is particularly favorable for a segmented autoencoding strategy [3]. The encoder efficiently processes and compresses the input images into a compact latent representation ready for transmission, while the decoder is sophisticatedly trained to address and correct common problems common in surface marine imagery, such as illumination variations and inherent noise.

An innovative feature of the technique is the use of a cosine coding mechanism

for data transmission. By dividing the hidden data of a satellite image, represented by 1024 data points, into separate cosine and sinusoidal components, the framework effectively doubles the data throughput within the same bandwidth. This approach not only optimizes bandwidth utilization but also significantly increases the system's resistance to noise interference. At the receiving end, the decoder carefully reassembles these split data streams to restore the original image data [4].

In addition, the integration of the JANUS communication standard is a key aspect of this methodology. JANUS, a protocol developed for underwater acoustic modems, plays a crucial role in ensuring seamless communication between different acoustic systems, thereby increasing interoperability and standardizing marine communications.

The effectiveness of this methodological approach is thoroughly evaluated using a two-pronged strategy that encompasses both expert visual inspection and quantitative metrics. This metric rigorously evaluates the accuracy of image restoration, focusing on critical parameters such as color accuracy and brightness.

In summary, this research represents a comprehensive and innovative approach that combines cutting-edge technologies in auto-encoding, image processing, and data transmission. By improving data transmission efficiency and image quality, the research aims to significantly increase the utility and effectiveness of maritime unmanned platforms. This methodology demonstrates the innovative steps taken to overcome specific challenges associated with marine unmanned platforms, offering a promising solution for developing marine technology.

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