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Application of Improved Semantic Communication Technology in Remote Sensing Data Transmission

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Abstract : Semantic communication is an emerging form of communication that realize intelligent communication by extracting semantic information of data at the source and transmitting it, and recovering the data at the receiving end. It can effectively solve the problem of data transmission under the situation of large data volume, low SNR and restricted bandwidth. With the development of Deep Learning, semantic communication further matures and is gradually applied in the fields of the Internet of Things, Uumanned Air Vehicle cluster communication, remote sensing scenarios, etc. We propose an improved semantic communication system for the situation where the data volume is huge and the spectrum resources are limited during the transmission of remote sensing images. At the transmitting, we need to extract the semantic information of remote sensing images, but there are some problems. The traditional semantic communication system based on Convolutional Neural Network cannot take into account the global semantic information and local semantic information of the image, which results in less-than-ideal image recovery at the receiving end. Therefore, we adopt the improved vision-Transformer-based structure as the semantic encoder instead of the mainstream one using CNN to extract the image semantic features. In this paper, we first perform pre-processing operations on remote sensing images to improve the resolution of the images in order to obtain images with more semantic information. We use wavelet transform to decompose the image into high-frequency and low-frequency components, perform bilinear interpolation on the high-frequency components and bicubic interpolation on the low-frequency components, and finally perform wavelet inverse transform to obtain the preprocessed image. We adopt the improved Vision-Transformer structure as the semantic coder to extract and transmit the semantic information of remote sensing images. The Vision-Transformer structure can better train the huge data volume and extract better image semantic features, and adopt the multi-layer self-attention mechanism to better capture the correlation between semantic features and reduce redundant features. Secondly, to improve the coding efficiency, we reduce the quadratic complexity of the self-attentive mechanism itself to linear so as to improve the image data processing speed of the model. We conducted experimental simulations on the RSOD dataset and compared the designed system with a semantic communication system based on CNN and image coding methods such as BGP and JPEG to verify that the method can effectively alleviate the problem of excessive data volume and improve the performance of image data communication.

Keywords : semantic communication, transformer, wavelet transform, data processing
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