IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

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DEEP HASHING WITH MULTI-LEVEL CONTRASTIVE LEARNING FRAMEWORK FOR REMOTE SENSING IMAGE RETRIEVAL

Abstract

As the benefits of remote sensing imagery in monitoring the Earth's environment and targets have gained widespread attention, the volume of satellite remote sensing data has grown exponentially. Therefore, efficiently and accurately retrieving information from massive remote sensing data has thus become a critically important issue. In response to this challenge, researchers have proposed the "deep hashing" method, which achieves rapid retrieval of massive images through combining the superior feature representation capabilities of deep learning with the rapid retrieval capabilities of hash learning.

Existing deep hashing methods typically extract features from remote sensing images using deep networks and then map these features to form hash codes. However, these methods primarily focus on global features during the feature representation stage, which limits the ability to distinguish between images of different classes with similar semantics information, and these limitations are further exacerbated during the hash coding stage. To address these challenges, we propose a novel deep hashing contrastive learning framework to effectively learn discriminative features by exploiting image invariance information at both the feature level and hash code level.

Specifically, our proposed framework involves two branches. In the training phase, the same image is fed into each branch after different image augmentation processes. At the feature level, we use category contrastive loss to ensure that features from different categories are well separated while those from the same category are close in feature space. At the hash code level, we propose the intra-class hash contrastive loss and inter-class hash contrastive loss. The inter-class hash contrastive loss preserves the differences between hash codes of images from different categories within the same branch, while the intra-class hash contrastive loss ensures consistency of hash code for the same image processed differently under different branches. By exploring invariance information at both levels, our approach effectively ensures that the model distinguishes remote sensing images with high semantic similarity but different category.

We conducted extensive experiments on widely used remote sensing image retrieval datasets, including AID and UCMD, and achieved superior results. For example, on the AID dataset, our method achieved mAP scores of 99. 54%, 99. 37%, and 99. 60% for 16 bit, 32 bit and 64 bits hash code lengths, respectively. Compared to state-of-the-art methods, our approach demonstrated improvements of 3.09%, 1.16% and 1.00% for the respective hash code lengths, which proves the effectiveness of our method on remote sensing image retrieval.