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Adaptive Object Detection in Construction Sites Using Parameter-Efficient Fine-Tuning with LoRA

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ABSTRACT

Construction sites exhibit highly variable characteristics depending on their location and construction phase. These dynamic conditions, such as changes in environment, personnel, and equipment, often degrade the performance of pre-trained object detection models. To address this challenge, fine-tuning general models for specific site conditions or construction stages is crucial, but this process can be computationally intensive and time-consuming.

This study explores the use of Low-Rank Adaptation (LoRA), a parameter-efficient fine-tuning technique, to adapt object detection models for dynamic construction environments. LoRA enables efficient model customization with significantly reduced training time and computational demands. Moreover, LoRA-generated weight files are much smaller than full model weights, making them ideal for deployment in edge computing environments common on construction sites. This compact format also allows seamless switching between models optimized for different conditions such as day and night or varying weather. The proposed method enhances the flexibility and practicality of computer vision systems in smart construction.

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