Dual Attention Convolutional Neural Network (Dacnn) For Road Condition Assessment Using 3D Laser Imaging Device

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New 3D laser imaging technology is increasingly used in road surveying projects due to its advantages over traditional 2D imaging technologies, such as less sensitivity to field illumination conditions and pavement noises (e.g., oil/water stains, dirts, sands, skid marks, etc.). The 3D technology also produces additional range (or depth) images while the 2D technology can produce only intensity images. The combination of intensity and range images with the 3D technology allows improved recognition of pavement objects. In this research, we develop a novel deep learning model, Dual Attention Convolutional Neural Network (DACNN) to process intensity and range images collected with 3D laser imaging devices. Using the mode attention module, DACNN can integrate heterogeneous contextual information of intensity and range images effectively in a mid-fusion manner. Compared to the conventional 2D technique with the intensity images only, we show that the complementary depth information with additional range images improves the classification performance, associated with the mode attention module. DACNN also uses a scale attention module to fuse contextual information in different scales to classify pavement objects with random sizes. Our experimental results show that capturing both global and local contexts improves the multi-class classification performance significantly. In our comparative study, the DACNN outperforms other CNN models widely used in pavement applications, including VGG16, VGG19, ResNet50, and DesNet121.