INVESTIGATING THE MOST EFFECTIVE DATA AUGMENTATION TECHNIQUES FOR ENHANCING IMAGE CLASSIFICATION PERFORMANCE IN CNN MODELS

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ABSTRACT

The proliferation of drones across various sectors has created the need for effective image classification techniques to accurately distinguish between drones and birds, particularly to mitigate potential hazards. This study addresses the challenge of improving image classification performance in Convolutional Neural Network (CNN) models through the application of data augmentation techniques. The primary objective is to identify the most effective augmentation techniques for enhancing precision, recall, accuracy, and F1 score in a CNN model using the "Bird vs Drone" dataset. Four augmentation techniques were evaluated: rotation, flipping, cropping, and color jittering. Initially, a baseline CNN model was trained without augmentation to establish a performance benchmark, achieving a precision of 0.5725, recall of 0.9375, accuracy of 0.6187, and an F1 score of 0.7109. Each augmentation technique was then applied separately and the performance of the model was re-evaluated. The results indicate that the flipping technique achieved the highest precision (0.9400) and accuracy (0.7750), proving to be particularly effective in reducing false positives while maintaining strong classification accuracy. Although rotation and cropping also increase precision and accuracy relative to the baseline, they exhibit lower recall values, suggesting a trade-off between false-positive reduction and the ability to detect all positive samples. Color jittering strikes a moderate balance, improving precision to 0.6591 and recall, leading to an increase in overall accuracy to 0.6750 and F1 score of 0.6905. This study demonstrates that data augmentation significantly enhances the CNN performance in image classification. Flipping is especially effective for increasing precision and accuracy, whereas color jittering helps to balance performance metrics. These findings offer valuable guidance for selecting appropriate augmentation techniques for optimal CNN performance in image classification tasks.

Keywords: Convolutional neural network, data augmentation, image classification, performance metrics, drone detection