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Exploratory analysis of modified deep learning model for potholes data augmentation

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Abstract

A major factor contributing factor resulting to a large proportion of vehicular-related traffic accidents in developing nations is the poor condition of road networks, characterized by potholes, bumps, and other anomalies. Despite efforts by authorities to address these issues, they persist. A new approach involves equipping vehicles with sensors to detect road anomalies, enabling drivers to make informed decisions. Various models using road surface images to detect and classify these anomalies have been proposed, with recent methods leveraging deep learning. The effectiveness of these models depends on the presence of abundant and well-labelled training datasets. To address this need, a modified Deep Denoising Diffusion Probabilistic Model (mDDPM) was proposed, enhancing the U-Net backbone architecture to improve the original DDPM's performance in augmenting pothole images. The mDDPM generates more diverse augmented images, evaluated through subjective and objective assessments, including the Fréchet Inception Distance (FID) score. Experimental results showed that 98% of participants could not distinguish between real and synthetic images, classifying the augmented images as real. Additionally, an FID score of 0.52 indicated that the augmented images closely resemble real pothole images. This demonstrates the model's effectiveness in generating training data for deep learning models aimed at road anomaly detection and classification, contributing to the development of robust models for detecting and classifying potholes and other road anomalies.