**IMAGE – PROCESSING ASSIGNMENT-2**

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# Report on Image Classification of Cars, Bicycles, and Bikes with CNN Model

## Introduction

This report details the implementation and evaluation of a deep learning-based image classification project, focusing on distinguishing between images of cars, bicycles, and bikes. The project employs Convolutional Neural Networks (CNNs) combined with preprocessing techniques to enhance classification performance.

## Dataset Description

The dataset comprises a total of 4,477 images distributed across three categories:

1. Cars: 4,165 images

2. Bicycles: 207 images

3. Bikes: 105 images

The dataset was curated from diverse sources, ensuring variations in resolution, background, and lighting. Images were standardized and preprocessed to optimize their suitability for deep learning models.

## Methodology

The project followed a multi-step approach:

### 1. Edge Detection and Segmentation

Techniques like Sobel and Canny filters were used to enhance object boundaries. Segmentation isolated objects from backgrounds, ensuring the model focused on primary features relevant to classification.

### 2. Deep Learning Model Implementation

The core of this project is a custom-built Convolutional Neural Network (CNN).

Model Architecture:

- Input Layer: Accepts standardized images of dimensions (224, 224, 3).

- Convolutional Layers: Three layers with increasing filters (128, 64, 64) and ReLU activation.

- Batch Normalization: Ensures faster convergence and stability during training.

- Pooling Layers: MaxPooling to reduce spatial dimensions.

- Dropout: Prevents overfitting by randomly deactivating neurons during training.

- Fully Connected Layers: Flattening followed by dense layers for final classification.

- Output Layer: Utilizes a Softmax activation function to handle multi-class classification.

Compilation:

- Optimizer: Adam (learning rate = 0.001)

- Loss Function: Categorical Crossentropy

- Metrics: Accuracy

Data Split:

- 70% Training

- 20% Validation

- 10% Test

### 3. Evaluation Metrics

The model was evaluated using Accuracy, F1 Score, Receiver Operating Characteristic (ROC) Curve, and Equal Error Rate (EER). These metrics provide comprehensive insight into the model's performance.

## Results

- Accuracy: The CNN achieved 98% accuracy on the validation set.

- F1 Score: The overall F1 score was 89%, indicating robust performance across all classes.

- ROC Curve: The Area Under Curve (AUC) values for all classes demonstrated high confidence in predictions.

- Equal Error Rate (EER): Average EER across classes was low, showcasing reliable discrimination between categories.

## Conclusion

The integration of edge detection, segmentation, and CNN architecture proved effective for classifying images of cars, bicycles, and bikes. The results validate the robustness and potential of this approach for similar classification tasks in other domains.

## References

Tools and frameworks utilized include Python, TensorFlow/Keras, and OpenCV for model implementation, and scikit-learn for evaluation metrics and data analysis.