ML Lab Week 14: CNN Image Classification

Name: Nitali Rajesh
SRN: PES2UG23CS395
Section: F

1.Introduction:

This lab focused on building and evaluating a Convolutional Neural Network (CNN) in PyTorch for an image classification task. The experiment used the "Rock-Paper-Scissors" dataset, which contains images of hand signs belonging to three distinct classes. The objective was to preprocess the data, design an effective CNN architecture, train it using supervised learning, and assess its overall performance. Throughout the lab, key deep learning concepts such as convolution operations, pooling, feature extraction, and optimization using gradients were explored.

2. Dataset Description:

The Rock-Paper-Scissors dataset includes over 2,000 colored images, organized into three folders representing each category. PyTorch's ImageFolder utility was used to automatically assign labels based on directory names. All images were resized to 128 × 128, converted into tensors, and normalized using a mean and standard deviation of 0.5 for each channel. The dataset was divided into an 80% training set and a 20% test set to evaluate generalization.

3. Model Architecture:

The implemented CNN consists of three convolutional blocks followed by two fully connected layers. Every block uses a 3×3 convolution with padding = 1 (to maintain spatial size), followed by a ReLU activation and a max-pooling layer, which halves the spatial dimensions.

Convolutional Blocks:

- Block 1: Conv2d(3 → 16), ReLU, MaxPool(2)
- Block 2: Conv2d(16 → 32), ReLU, MaxPool(2)
- Block 3: Conv2d(32 → 64), ReLU, MaxPool(2)

After three consecutive pooling operations, the image size reduces from 128×128 to 16×16, resulting in a flattened feature vector of 64 × 16 × 16 = 16,384 elements.

Fully Connected Layers:

- Linear(16384 → 128) with ReLU
- Linear(128 → 3) for final classification

This architecture is computationally lightweight yet capable of capturing shape and texture patterns essential for gesture recognition.

4. Training and Performance:

The network was trained using CrossEntropyLoss and optimized using Adam, chosen for its adaptive learning capabilities. A learning rate of 0.001 provided smooth convergence, and the model was trained for 10 epochs with batches of 32 images.

The final model achieved:
Test Accuracy: 97.49%

```
Epoch 1/10, Loss = 0.5978
Epoch 2/10, Loss = 0.1628
Epoch 3/10, Loss = 0.0858
Epoch 4/10, Loss = 0.0393
Epoch 5/10, Loss = 0.0343
Epoch 6/10, Loss = 0.0121
Epoch 7/10, Loss = 0.0090
Epoch 8/10, Loss = 0.0114
Epoch 9/10, Loss = 0.0033
Epoch 10/10, Loss = 0.0012
Training complete!
```

This high accuracy indicates that the CNN successfully learned to discriminate between the three gesture categories.

Hyperparameter	**Value**
Optimizer	-> Adam
Loss Function	-> Cross EntropyLoss
Learning Rate	-> 0.001
Epochs	-> 10
Batch Size	-> 32
Test Accuracy	-> 97.49%

5. Conclusion & Analysis:

The CNN model achieved excellent performance, demonstrating a high capability to distinguish between rock, paper, and scissors gestures. The structured dataset, combined with appropriate preprocessing and a well-designed convolutional pipeline, contributed to the strong results. Potential improvements include adding data augmentation, experimenting with deeper architectures, incorporating dropout layers for regularization, and training for additional epochs to explore further accuracy gains.

Output 1

```
Randomly selected images:
Image 1: /content/dataset/scissors/Me6SACZZ4EYJLHbB.png
Image 2: /content/dataset/scissors/LNyVq7Qg9M0S6RMZ.png

Player 1 shows: scissors
Player 2 shows: scissors

RESULT: Draw
```

Output 2

```
Randomly selected images:
Image 1: /content/dataset/paper/8cUuoeM7qSsAGoOv.png
Image 2: /content/dataset/scissors/6drquJLYR4bjZX2E.png

Player 1 shows: paper
Player 2 shows: scissors

RESULT: Player 2 wins! scissors beats paper
```

Output 3

```
Randomly selected images:
Image 1: /content/dataset/scissors/JKlTmX8oKzganNsN.png
Image 2: /content/dataset/paper/RJrQJX31bej6flMr.png

Player 1 shows: scissors
Player 2 shows: paper

RESULT: Player 1 wins! scissors beats paper
```