

Internship Report: Handwritten Character Recognition

Internship Project Title:

Handwritten Character Recognition using Deep Learning

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Internship Organization:

CODE ALPHA

Objective:

To build a machine learning model capable of identifying handwritten digits and characters using image processing and deep learning methods.

Tools & Technologies Used:

- Python
- Google Colab
- TensorFlow / Keras
- OpenCV
- Matplotlib
- NumPy
- MNIST and EMNIST Datasets

Dataset Description:

- **MNIST:** Contains 70,000 grayscale images of handwritten digits (0-9).
- **EMNIST:** Extended version including letters (a-z and A-Z).
- Each image is 28x28 pixels.

Methodology:

1. Data Preprocessing:

- Resizing, normalizing pixel values, reshaping input
- One-hot encoding labels

2. Model Building:

- Convolutional Neural Network (CNN)
- Layers: Conv2D → MaxPooling → Flatten → Dense → Softmax

3. Training:

- Trained on 60,000 images
- Validation on 10,000 images
- Loss Function: Categorical Crossentropy
- Optimizer: Adam

4. Evaluation:

- Achieved high accuracy on test data
- Evaluated using confusion matrix, precision, recall

Results:

- **Digit recognition accuracy:** ~98.5%
- **Character recognition accuracy (EMNIST):** ~92%
- Correctly identified most letters and digits with minimal misclassification.

Applications:

1. Digit/letter input for mobile devices
2. OCR (Optical Character Recognition)
3. Postal code detection
4. Bank cheque reading
5. Digitizing handwritten documents

Conclusion:

The CNN-based model was highly effective in recognizing handwritten characters. With further enhancements like CRNN (for sequences), the system can be extended to recognize full words or sentences.

Screenshots Outputs:

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz
11490434/11490434 ————— 0s 0us/step
/usr/local/lib/python3.11/dist-packages/keras/src/layers/convolutional/base_conv.py:107: UserWarning:
    super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Epoch 1/5
1875/1875 ————— 50s 25ms/step - accuracy: 0.9004 - loss: 0.3189 - val_accuracy: 0.9
Epoch 2/5
1875/1875 ————— 83s 26ms/step - accuracy: 0.9850 - loss: 0.0496 - val_accuracy: 0.9
Epoch 3/5
1875/1875 ————— 83s 26ms/step - accuracy: 0.9885 - loss: 0.0346 - val_accuracy: 0.9
Epoch 4/5
1875/1875 ————— 50s 27ms/step - accuracy: 0.9929 - loss: 0.0233 - val_accuracy: 0.9
Epoch 5/5
1875/1875 ————— 79s 25ms/step - accuracy: 0.9952 - loss: 0.0154 - val_accuracy: 0.9
313/313 ————— 4s 11ms/step - accuracy: 0.9855 - loss: 0.0468
Test accuracy: 0.9894000291824341
```

GitHub Link: [https://github.com/Kusuma1823/Code_Alpha_Handwritten_Character_Recognition]

